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SCIENCE

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THE RELATION OF CHEMICAL LABORATORIES TO THE NATIONAL WELFARE[1]

FOR two years and a half the world has been in a ferment. On the basis of an incident which now seems trivial, the mutual jealousies and distrust of the nations of Europe precipitated a war in which the interests of all the nations of the world are involved. Those of us who think that our race is progressing toward better conditions can not but believe that there will grow out of this war some better method of settling differences between nations. The duel as a means of settling private quarrels has long since disappeared in England and America. It must surely cease as a means of settling quarrels between nations. It seems certain that the time will come when the world will look back to these years as a time of madness like the madness that drove men to the crusades of the middle ages.

With all the loss and waste and dreadful suffering of these years the nations of the world are learning some lessons which would not have been learned in times of peace. Russia has solved her liquor problem for the time being. Germany enforces a democratic equality in the distribution of food which is beyond the wildest dream of the socialists. Bread is distributed by cards and the wealthiest citizen can get no more than the day laborer. England has solved the problem of the unemployed—there is no longer a "submerged tenth" for whom conditions are utterly hopeless. One of my friends who has been in London with his family reports that his wife was commiserating her charwoman on the suffering of the war, when the latter replied: "It's not so bad—a pun' a week and the man away from home—it's too good to last."

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[1] An address delivered at the dedication of the chemical laboratory of the University of Oklahoma, January 26, 1917.

In America, too, we are learning some lessons—among others that our industrial independence, at least in the matter of dyes for our textiles, is of some importance.

If we try to find a single word which expresses that for which all of the warring nations are striving it is *efficiency*. It seems very dreadful that the desire to slaughter our fellow men should be the incentive, and if we did not believe that the lessons learned under the stress of war will remain during the long years of peace that are to follow, we might well wish for the good old times before scientific efficiency was thought of. But whether we will or not a new sort of efficiency has come to stay and it is worth our while, here in America, to grasp its meaning and to look for the foundation on which it has been built.

I see with the eyes of a chemist, of course, and shall draw my illustrations from the science which I know best, but much that I have to say applies to other sciences as well.

A little less than one hundred years ago, shortly after Europe had settled down from the tumult of the Napoleonic wars a young German doctor of philosophy, not yet out of his teens, went to Paris to study chemistry and succeeded in gaining admission to the private laboratory of Gay Lussac. Liebig was a born chemist, if ever there was one, and had worked with things chemical from early boyhood. But even Liebig needed the inspiration of contact with one of the master chemists of his time, and this Gay Lussac gave him. After a few months he returned to Giessen and there in a laboratory which was new of its kind in university life he gathered about him an enthusiastic group of young men who came to him for the study of chemistry. The laboratory was very crude and primitive in comparison with the palaces of science which we build to-day, but out of that laboratory went influences which have spread over the whole world—Liebig's idea of a laboratory was not that it is chiefly a place for teaching what is already known, but rather that it is a workshop where teacher and pupil are striving together to learn something new from the great book of nature. Very soon many similar laboratories sprang up and within a few years Germany became the country to which young men resorted from all over the world for the study of chemistry.

A. W. Hofmann, one of the talented young men of the Giessen group, was called to London by Prince Albert in 1845. There he taught in the college of chemistry. He employed as an honorary assistant, some years later, a young man by the name of William H. Perkin. Young Perkin became so interested in the subject that he was not content merely to work with Hofmann during the day, but he fitted up a private laboratory at home where he could work at night. Here he tried to do some experiments in the hope of obtaining a synthesis of quinine. His first experiments gave an unattractive reddish brown precipitate of the sort that most chemists would pass by as hopeless. He became interested, however, and tried similar experiments with a simpler substance, aniline. The product was at first still more unpromising, but on further examination he found that it contained a beautiful purple coloring-matter which was capable of dyeing silk and other textiles. It was in fact the substance we now know as the "Mauve dye." Perkin, then a lad of only eighteen years, conceived the daring idea that this color might be put to practical use. Fortunately his father had faith enough in his ability to furnish him with the necessary financial assistance. It was a new thing under the sun and it is fascinating to read of the difficulties met and overcome in developing the industry of the coal-tar dyes. The benzene which is now separated from coal-tar to the amount of thousands of tons annually was not to be had as a definite product and it was necessary to invent the machinery and apparatus for carrying out on a large scale operations which, hitherto, had been tried only in test-tubes. Even when the new dye had been made, the dyers, who were accustomed only to vegetable dyes, could not use the product and Perkin had to go into their dyehouses and teach them how to handle the material. All of these difficulties were finally overcome and a successful foundation was laid for a great industry, which in less than a generation revolutionized the artistic beauty of our wearing apparel.

A few years later two German chemists solved the riddle of the structure of alizarin, the coloring matter of madder root, and showed that the dye could be made from the anthracene of coal tar. They did not, however, put the production of the material on a commercial basis and here, again, it was William H. Perkin who worked out the economic details of manufacture in his factory.

With such a beginning it would have seemed that England must be the leader in the manufacture of artificial dyes, but long before the end of the nineteenth century Great Britain had lost all her initial advantage and Germany was preeminent in the production of synthetic colors.

When we look for the reason for this surprising result we find it almost entirely in the laboratories founded on Liebig's ideal —laboratories where students learned the chemistry already known, it is true, but where, much more than that, and as their prime object, teachers and pupils gave their energies intensely and incessantly to the development of an ever-changing science. Young men trained in such an atmosphere proved to be the very ones who could solve the varied problems of an industry which is so intimately connected with investigations in pure science. In addition to the supply of trained chemists furnished by the universities there grew up a most intimate connection between the university laboratories and the factories where dyes were made. An illustration will help to make this clear. Kekulè, one of the men who worked with Liebig in Giessen, proposed his theory of the structure of benzene in 1865. This has become, perhaps, the most important single thought guiding the work of the color-chemists even to the present day. Baeyer, who had studied with Kekulè, took up, in the same year, some work on isatin, an oxidation product of indigo. He tells us with what pleasure he had spent for a piece of indigo a birthday present of two thalers, given him when he was thirteen, and with what a feeling of reverence he drew in the odor of orthonitrophenol while he was preparing isatin from it by the directions which he found in an organic chemistry.

After working upon isatin and other derivatives of indigo for four years with good success Professor Baeyer dropped the subject for eight years because his former teacher Kekulè published a paper in which he announced that he was attempting a synthesis of isatin. It was evident that Kekulè did not succeed and in 1877 Baeyer felt justified in taking up the subject again. Three years later he discovered a synthesis of indigo which was of sufficient promise for a patent and the Badische Anilin Soda Fabrik began at once an attempt to put the synthesis on a manufacturing basis. But a successful synthesis in the laboratory is very different from successful production in a factory. The chemists of the factory worked over the process from every possible point of view for fifteen years. The various steps in the process were greatly improved and more than a hundred patents were taken out, but it was never possible to convert Baeyer's synthesis into a successful manufacture of indigo on a large scale. The original material required for that synthesis is the toluene of coal tar and the annual production of this substance would be sufficient to produce only about one fourth of the indigo required in the world. As toluene is used in the manufacture of a great variety of other dyes and compounds it is evident that any considerable use for the manufacture of indigo would cause such an increase in price as automatically to stop the manufacture. No manufacture of indigo could succeed unless the dye were made at a price to compete with the agricultural production in India.

The factory found its way out of this *cul-de-sac* by means of a discovery made by Professor Heumann in the chemical laboratory of the Polytechnic at Zurich, Switzerland—a laboratory which has given us many brilliant discoveries in chemistry and which is conducted on a high scientific plane, not on the theory that it must devote itself to so-called practical problems. By combining Heumann's discovery with another made by Hoogewerf and van Dorp in a laboratory in Holland it became possible to manufacture indigo with naphthalene of coal tar as the starting-point. Naphthalene, known to us all in the familiar moth balls, is abundant and cheap.

Even with the aid of these fundamental discoveries from the university laboratories the chemists of the factory worked incessantly upon the problem for seven years before they felt sufficiently sure of their ground to recommend the building of a plant for the manufacture on a large scale. Two incidents of the development are of sufficient interest to deserve mention. The first step in the process is the oxidation of naphthalene to phthalic acid. The processes which had been used before that were too tedious and expensive. In the course of a systematic examination of all possible methods for cheapening the process a chemist accidentally broke a thermometer in a mixture of naphthalene and sulfuric acid which he was heating. The mercuric sulfate which was formed proved to be the needed catalyst to hasten the reaction and the details of a successful process for the oxidation were soon developed. But, as is so often the case, the solution of one problem brought out a second difficulty. Strong sulfuric acid is required for the oxidation and this is reduced to sulfur dioxide, which it is necessary to recover and convert back into the strong acid by oxidation with air. This led to the transformation of the old and well-known contact process for the manufacture of sulfuric acid into a new and radically changed form. Incidentally it may be remarked that the new contact process soon found its way to America and has been used to convert to sulfuric acid the sulfur dioxide obtained as the first step in the reduction of zinc ores. The strong sulfuric acid has been used, in turn, in making dynamite.

Finally, in July, 1897, the preliminary work was completed and the Badische Anilin Soda Fabrik was ready to begin the construction of the necessary factories. In October, 1900, Dr. Brunck reported that the firm had spent about eighteen million marks or four and a half million dollars upon their plant and that the production had already attained a proportion which corresponded with the natural production from 100,000 hectares or nearly 250,000 acres of land. In reply to the suggestion that the competition might prove disastrous to the farmers of India he expressed the hope that the land now used for the production of indigo may be released for raising food stuffs, often sorely needed during the famines in that country.

It has seemed worth while to consider this development of the manufacture of indigo in detail because it points out so clearly the road which we must travel in America if we are to succeed in the color industry. It is a lesson which American manufacturers are learning, too, and this promises well for the future. A manufacturer in Michigan has recently taken a promising research worker in organic chemistry from the University of Michigan to help him develop the manufacture of indigo, and another manufacturer in Buffalo last summer called a man from the University of Illinois at twice the salary he was paid there, to organize a research laboratory for the manufacture of dyes. In each case the man secured his training in the research work of a university laboratory.

At the beginning of the war we were using dyes in the United States to the value of about $15,000,000 a year. Of this amount only about $3,000,000 worth were made in America. Nearly all the rest came from Germany. Textile industries having a product worth hundreds of millions are directly dependent on dyes and there is scarcely a person in this country who has not seen in some form the effect of the shortage. The dye manufacturers have been alive to the situation and in another year they will be able to furnish the quantity of dyes required, though they will not be able to furnish as great a variety as were formerly used.

We have heard a good deal, in recent years, about a scientific tariff commission. The action of Congress last summer illustrates the need of such a commission. The importance of making ourselves independent of other countries had become so evident that a bill was introduced providing for an *ad valorem* tax on dyes of 30 per cent. and a specific tax of 5 cents per pound. The specific tax is to continue for five years. At the end of that time it is to be decreased one cent a year till it disappears. There is also a provision that if the American factories do not produce 60 per cent. of the value of our home consumption at the end of five years the specific duties are to be completely repealed. While the specific duty is only two thirds of the amount which had been recommended by the New York Section of the American Chemical Society, it might, perhaps, have been sufficient if it were not for another provision which was allowed to creep in. Apparently at the instigation of some large user of dyes, indigo, alizarin and their derivatives were excluded from the specific duties. No logical reason, whatever, can be given for this exclusion. It must be due either to stupidity or to an attempt to favor some special interests. As this class of dyes constitutes 29 per cent. of the whole and at least 10 per cent. of the other dyes are covered by foreign patents, it is evident that the hope that our factories will produce 60 per cent. of our dyes in normal conditions of foregin competition is small.

Still other difficulties beset the industry. The manufacturers of dyes in Germany have very definite arrangements by which one dye is made by one firm, another by a second, and still another by a third so that there is no real competition in the manufacture of staple products. Such combinations are fostered rather than hindered by the German government, but similar combinations in this country are forbidden by the Sherman law. The way out of this difficulty seems to be in the first place a census of dyes showing what dyes are used and the quantities of each. Such a census has already been prepared by the expert of the Department of Commerce and Labor. If we can combine with this, in accordance with a suggestion of Dr. Herty, the editor of our *Journal of Industrial and Engineer-*

ing Chemistry, a frank statement by manufacturers, of the dyes which they intend to make, we may find a solution of this problem which is in accord with the democratic equality of opportunity which the Sherman law is designed to conserve.

The greatest fear of the manufacturers is that after the war they may be subjected to an unfair competition designed to destroy the new industry. The following story was told during a discussion of the dyestuff situation which was held in New York in September. Mr. Dow, of Midland, Michigan, discovered a good many years ago that the salt brines of Michigan contain enough bromine so that the element can be economically produced, and in the course of a few years he developed the manufacture to such a point that he shipped some bromine to Germany. Not long after a German appeared at his works in Midland and said to him: "I have conclusive evidence that you have been selling your bromine in Germany. Didn't you know that you can't do that?" Mr. Dow replied that he knew of no law against it. The German said "Well you can not. If you do, we will sell two pounds of bromine in America for every pound you sell in Germany." Mr Dow paid no attention to the threat but went on with the production of bromine. Some months later when he was in Texas on business he received a telegram "Bromine is selling at 15 cents." A normal price is 75 cents. Mr. Dow closed his story at this point. The representative of the German Kali-Industrie, who was present, got up and asked him: "Well, wasn't it satisfactorly adjusted?" But he made no reply. I am fortunate enough to have heard the rest of the story —which is known to a good many outsiders, so I am betraying no confidence in telling you. Mr. Dow stopped selling bromine in America and sent his whole product to Germany. It was not long before the German manufacturers were ready to come to terms. Before the war Germany was manufacturing three fourths of the coal-tar dyes used in the world and we may be sure that she will not easily relinquish her position of preeminence in this field. Her manufacturers will surely attempt to destroy our manufacture of dyes by the same methods which were used to stop the manufacture of bromine—by the so-called "dumping" of materials here at prices below the cost of production. Laws have been passed by Congress imposing severe penalties for such practises, but some of our manufacturers are very sceptical as to their efficiency. We are not in as favorable a position to compete in the making of dyes as Mr. Dow was for the production of bromine.

I think it is clear from what has been said that the manufacture of dyes rests at its foundation upon the research work done in the chemical laboratories of the German universities and that we may trace it back very directly to the days when Liebig returned from France with the inspiration which came from Gay Lussac, and founded the laboratory in Giessen. One of the most important factors in the dreadful efficiency of Germany during the last three years may be traced back to the same source. Not a few of our leading men have emphasized the advantage of developing the dyestuff industry in America because the men trained in this industry will be most competent to handle the manufacture of explosives in case of war. Personally I have a strong hope that at the close of the war the world will be organized on the basis of justice instead of force, but for the present we can not ignore such arguments.

I wish to congratulate you on the completion of this laboratory at a most opportune time. We are in the midst of a very rapid development of our chemical industries. New lines of manufacture are being established and old lines are being rapidly developed. Manufacturers realize as they have never done before how much chemistry can contribute to their success.

At the risk of seeming personal I will give a few illustrations of how chemical research in a single laboratory has demonstrated its value under American conditions.

A young man graduated from the course in chemical engineering at the University of Illinois in 1910. Soon after he was employed by a manufacturer of cement in the state of Washington. Something had gone wrong in the factory and hundreds of barrels of cement were rejected because the material did not meet the specifications. The young graduate, trained in methods of research, soon found the cause of the difficulty and corrected it and the firm has continued in the successful manufacture ever since.

In 1907 a graduate of Worcester Polytechnic Institute who had spent one year at the Massachusetts Institute of Technology came to Illinois as a research assistant. He completed his work for the degree of Ph.D. three years later and was continued as an instructor and later became assistant professor in charge of the division of organic chemistry. In 1916 one of the oldest of the firms manufacturing dyes in America searched the country over to find a man to organize their research laboratory. They selected this man, not because of any experience which he had had in industrial work, but because of his record as a research worker in pure organic chemistry and because of his ability to apply the principles of physical chemistry to this field.

Another young man, a graduate of Oberlin College and trained in research by Edgar F. Smith, of the University of Pennsylvania, came to Illinois in a subordinate position in 1907. During the eight or nine years following he became one of the leading workers in this country in researches upon the rare earths, and he was gradually advanced to the position of professor of inorganic chemistry. Two or three years ago he was asked by a firm in Chicago to assist them in the details of an important application of tungsten to an industrial use. He solved the problem and the result proved to be of large commercial value. Last year he was asked by the firm to organize a research laboratory to study the application of rare metals to industrial uses.

Another chemist who graduated at Illinois and afterwards took his degree of Ph.D. at Wisconsin is now state food commissioner of Illinois. There is not a man, woman or child in the state of Illinois who is not directly or indirectly dependent on this chemist for the maintenance of proper standards for the food which he eats.

Many similar illustrations of the importance of trained chemists might be given by any large university in America.

Such a laboratory as this has three important functions to perform. It must give an elementary knowledge of chemistry to many students who will not become chemists, but who yet should study the subject because chemistry touches the life of every one at many points. But this part of the work will be very poorly done if it merely imparts a set of so-called practical facts about every day life. Such facts will be quickly forgotten, but chemistry, better than almost any other science, furnishes a basis for clear scientific thinking and for students to acquire the habit of reasoning from one point to another in such a manner as to connect and combine their knowledge into a coherent, logical system. The discipline acquired in this way is of greater value than any set of facts that may be learned.

In the second place the laboratory will train a few men who will find their way into chemistry as a profession—it may be into some of the industries to which I have referred, or to become teachers, or to work in our experiment stations over the important applications of chemistry to agriculture.

The third and most important function of the laboratory is the contribution which it makes to the growth of our science. Here in Oklahoma you have many problems which can be solved with the aid of chemistry. But just as Germany would have failed utterly to reach her highest achievements if her university professors had confined themselves to so-called practical problems, so this or any other university will fail if its staff does not devote a considerable part of its energies to the advancement of the science of chemistry quite irrespective of whether industrial applications for the results of their researches are apparent or not. No chemical laboratory has a right to call itself a university laboratory if it loses sight of this, the highest of its functions. A high-school may devote itself exclusively to teaching and a college may possibly do the same, though of that there is serious question. For the university there can be no question. Ours is a vital, growing, rapidly changing science and only those who are intensely interested in its growth can properly teach and inspire those who are to go out into the world and use for the advantage of themselves and of the state the training they gain in university halls.

WILLIAM A. NOYES

MILITARY GEOLOGY

MODERN warfare is a science, or rather an application of many sciences, and therefore it can afford to neglect no scientific field the cultivation of which would make for added superiority, in however slight degree. The usefulness of certain sciences to the carrying on of war is obvious or has been made so by the conditions of the European contest: such are surgery and chemistry; the military application of certain other sciences, however, is not so apparent and needs to be pointed out from within the subject itself: thus it is with geology. If the service that this science can render to the country in time of war be clearly established, then it follows that geology will be incorporated in our plan of military development and be called upon to do its proper part in furthering the military effectiveness of the nation.

This is a new rôle for geology, but a rôle already played and established in the theater of war in Europe. Military geology is a phase of applied science that has served the warring nations abroad; it sees many duties that it may perform for the United States.

In the first place, geological knowledge may be employed to advantage by an army in the field. "What a Geologist Can Do in War," is the title of a brochure prepared by R. A. F. Penrose, Jr., for the geological committee of the National Research Council and published in April, 1917. This short essay in scarcely more than a thousand words specifies clearly the varied service that a knowledge of geology can render, not only to the army in camp, but to the army on the march and in battle. The importance of this service may be judged by observing some of the problems arising in the course of field operations, which the geologist might appropriately be expected to solve.

The selection of camp-sites involves problems in drainage and sanitary arrangements, which become more difficult of solution in marshy country; in arid regions the possibility of disastrous cloudbursts destroying camps improperly located demands attention. Trenches and tunnels must be placed, so far as strategic conditions allow, in easily workable and drainable rock formations; while the stability of slopes depends upon the material in which the excavations are made. Ground for artillery positions should be selected not only from topographic considerations, but also in respect to the firmness and elasticity of the underlying rock, upon which the accuracy of fire will in part depend. The construction or repair of roads is a frequent military need, the more important because of the necessity for transporting heavy artillery, for which the ordinary road-bed is inadequate.

Topographic maps carry a special meaning for the trained geologist while geological maps yield information of value in regard to the strategic quality of the country of advance; even without maps the geologist can draw inferences as to the ease and safety with which the country ahead may be traversed. The vibration effects of prolonged artillery fire in mountainous regions are likely to cause landslides and snowslides, which may prove disastrous if not anticipated and guarded against; but vibrations arising from the enemy's fire may be turned to advantage through seismographic records, showing the point of origin. Lastly, the question of an adequate water-supply is ever present, and the ordinary sources may often be enlarged or improved upon by the location of underground or artesian waters, while in deserts the avoidance or chemical improvement of waters too strongly alkaline becomes frequently of paramount importance.

In these respects, then, an army without geological knowledge is at a disadvantage; for the problems mentioned are all within the capabilities of the geological engineer and some of them must remain unsolved if geological advice is not at hand.

In the second place, an army employing geologists in its field activities can facilitate their effectiveness by maintaining a geological department at home for the accumulation of geological data and in particular of geological maps covering all possible regions of military activity. It is no small task to assemble such material in form and quantity suitable for use on short notice in any part of the world. Such a department, therefore, should be established in advance of field operations. A new type of map recently employed by physiographers, which shows by a block diagram both the topographic features and the underlying rock structures, would without question prove of distinct advantage to commanding officers planning a campaign or executing field manoeuvers. Few maps of this kind have ever been constructed; their preparation is slow and requires considerable skill and knowledge. It would fall within the province of the home office to develop the usefulness of this sort of map. The department also would appropriately assemble information on the water resources of regions of prospective occupation, so that the geologist in the field might be supplied with such results of previous geologic work, particularly in the enemy's country, as would facilitate his search for sources of water-supply.

A third way in which geology can contribute to the military strength of a country is through a study from a military standpoint of its mineral resources, the raw materials of war. In the United States, our mineral resources have long been the subject of organized investigation on the part of the Geological Survey, which has accumulated detailed and accurate information regarding them of the highest value at the present time. But the investigations of the Geological Survey have naturally been confined largely to the economic and scientific aspects of its field, and while much of its information can be quickly interpreted in terms of military necessity, the fact remains that this accumulated knowledge, much of it of the deepest military significance, has remained largely unused by military authorities, and the United States to-day is unprepared in respect to a few mineral products essential to war, such as nitrogen, potash, manganese, nickel, tin, and platinum. This country as a whole, however, is at a relatively efficient stage of preparedness in regard to her mineral industry, not because the government has studied and anticipated her military needs in this respect, but because recent economic demands have in most particulars been analogous to impending war demands, and hence the mineral industry under present economic conditions is largely on a military footing. But this does not obviate the desirability of a further military-geological study of our mineral wealth, for conditions are ever changing and we should anticipate every eventuality. In the future, the military importance of minerals is bound

4. Varieties of grain best adapted for the locality should always be used. The agricultural colleges and other state agricultural agencies will inform the farmers of the existence of these varieties and how and where to obtain the seed.

5. Every means should be employed to eliminate weeds, by use of clean seed, crop rotations, early cultivation above mentioned, and any special methods reliably recommended for particular weeds in different localities.

6. Seed testing for germination can well be further emphasized at this emergency period. The extension service, through county agents, should bring this matter home to every farm.

7. Seed treatment will largely prevent certain smuts and other diseases of cereals, and, as a real war measure, we are bound to see that it is applied as nearly as possible on every farm, thus increasing our cereal production a hundred million bushels or more, in one season. By field demonstrations the methods can and should be made plain to all concerned.

8. The possible ravages of Hessian fly, chinch bug, green bug, stored grain and mill products insects, etc., must be kept also in mind and the progress of and means of checking these insects be communicated, so far as possible, in advance of their local occurrence

9. As a means of reducing the great loss from rust, it is urged that all common barberry bushes (not the Japanese) and grass weeds harboring cereal rusts, be eradicated, and that rust-resistant cereal varieties be grown, if otherwise of good quality.

10. It is a conservative estimate that 20 million bushels of wheat and proportional quantities of other cereals are annually lost by waste in harvesting and thrashing. This waste can and and should be, in large measure, easily avoided. A man and team are known to have cleared $27 to $62 a day from cleaning up after thrashers, and, in another instance, last year in Kansas, $500 was gained by a man, with a team and fanning mill, cleaning up after thrashing machine settings, in three weeks' time.

11. In the western and southwestern plains, grain sorghums should be widely planted. In the northern plains, in the drier districts, flax and, under certain conditions, proso or Russian millet, may be used to a similar advantage.

12. Suitable catch crops (such as cowpeas, soy beans, sorghums, millet, flax and buckwheat) should be grown on all lands on which staple crops can not be seeded at the proper time or on which they have been destroyed.

13. The increased use of corn, rice, grain, sorghums, proso, barley, rye, beans, cottonseed meal and peanut meal as substitutes for, or in conjunction with, wheat for human food is strongly recommended. Information on this matter can be obtained through the state agricultural colleges and the United States Department of Agriculture.

ORGANIZATION OF THE ENGINEERING COUNCIL

On June 27 was held the first meeting of the Engineering Council. This body is a department of the United Engineering Society and has recently come into being as a medium of cooperation between the four national engineering societies. The function of the council may perhaps best be described by the following extract from the by-laws of the United Engineering Society:

> The council may speak authoritatively for all member societies on all public questions of a common interest or concern to engineers.

The council is composed of twenty-four members, five being appointed by each of the four founder societies and four by the United Engineering Society. Its present membership follows:

American Society of Civil Engineers.—J. F. Stevens (Chas. Warren Hunt), George F. Swain, F. H. Newell, Alex. C. Humphreys, F. D. Galloway.

American Institute of Mining Engineers.—P. N. Moore, S. J. Jennings, B. B. Lawrence, J. Parke Channing, Edwin Ludlow.

American Society of Mechanical Engineers.—I. N. Hollis, Chas. Whiting Baker, John H. Barr, A. M. Greene, Jr., D. S. Jacobus.

American Institute of Electrical Engineers.—H. W. Buck, E. W. Rice, N. A. Carle, P. Junkersfeld, C. E. Skinner.

United Engineering Society.—Clemens Herschel, B. B. Thayer, I. E. Moultrop, Calvert Townley.

At the organization meeting held in the rooms of the American Society of Mechanical Engineers at 2.30 o'clock P.M., on the twenty-seventh instant, the following officers were elected:

President: I. N. Hollis.
Vice-presidents: H. W. Buck, George F. Swain.
Secretary: Calvert Townley.
Executive Committee: The four officers named, [illegible] J. Parke Channing and D. S. Jacobus.

The council discussed at length ways and means by which the founder societies through the council may be of use to the nation. The unanimous desire to help the government in the prosecution of this war resulted in a resolution instructing the executive committee to cooperate with the government in procuring the services of engineers, also the appointment of a committee of three consisting of Messrs. H. W. Buck, A. M. Greene, Jr., and Edmund B. Kirby, to consider the best means of utilizing the inventive ability of members of the founders societies.

The secretary was instructed to inform all government bureaus that might be interested in the organization of the Engineering Council and its desire to be of assistance.

SCIENTIFIC NOTES AND NEWS

The Index to Volume XLV. of Science is published with the present issue. It is sent to libraries and to those who have requested that copies of the index be sent regularly. It will be sent to any subscriber on application.

The degree of D.Sc. has been conferred by Williams College on Robert Grant Aiken, '87, since 1895 astronomer at the Lick Observatory.

At its ninety-sixth annual commencement the George Washington University conferred its doctorate of science on George Perkins Merrill, of the U. S. National Museum; on Elmer Ernest Southard, of the Harvard Medical School; on Arthur Powell Davis, of the Reclamation Service, and on Frederick Fuller Russel, major, Medical Corps, U. S. Army.

The University of Arkansas has conferred its doctorate of laws on the governor of the state, Charles H. Brough, who before his election was professor of economics and sociology in the university.

Sir David Prain, director of the Kew Botanical Gardens, has been elected president of the Linnean Society.

Alfred H. Brooks, formerly in charge of the Division of Alaskan Mineral Resources of the U. S. Geological Survey, has been appointed a captain in the Engineer Officers Reserve Corps and ordered to report for training. During Mr. Brooks's absence on military duty, Mr. George C. Martin will be geologist, acting in charge of Alaskan work.

We learn from *Nature* that Mr. J. Ramsbottom, of the department of botany, British Museum, has been appointed protozoologist to the medical staff at Salonika. The trustees of the museum have accepted Miss Lorrain Smith's offer to act as temporary assistant in charge of the fungi during Mr. Ramsbottom's absence.

Miss Amy Walker, M.A., Smith College, has been appointed research assistant in the chemistry of foods, Massachusetts Institute of Technology, under the Ellen H. Richards Fund, for the year 1917–1918. The work will be carried on under the direction of Professor A. G. Woodman, and it is proposed to study chemical changes, with special reference to the nitrogen compounds, which take place when fish decomposes before and after heating at relatively high temperatures. This question is of particular interest in the sardine industry.

Sir Ernest Shackleton has now returned to England, after lecturing in Australia and America. He has received a commission in the army.

Professor Joseph S. Ames, of the Johns Hopkins University, who was sent to France early in April under the auspices of the Council of National Defense, has returned to Baltimore. Professor Ames will report on the development of aeronautics.

Dr. H. D. Dakin, who was appointed last March, with Dr. Alexis Carrel, to have charge of the military hospital which is being constructed and equipped by the Rockefeller Foundation on the grounds of the Rockefeller Institute of Medical Research, has returned to New York. Dr. Dakin went over to France in April to consult with Dr. Carrel, with whom he worked during 1915 and 1916 as a bacteriologist.

The Linnean Society, London, has presented the Linnean gold medal to Mr. H. P. Guppy for his services to biology, and the

Crisp medal to Dr R J Hilliard, of the University of Sydney

Dr J M Coulter, head of the department of botany University of Chicago, delivered the annual Phi Kappa Phi address at the Kansas State Agricultural College on May 15 The subject of Dr Coulter's address was "Science and the public service"

Dr Frank Waldo, of Cambridge, formerly professor in the U S Signal Service, has volunteered a series of eighteen lectures on meteorology to the men at the Squantum aviation camp of the Massachusetts Institute of Technology

Professor H H Bartlett, of the University of Michigan, has given, during the week of May 21 26, a series of five lectures, under the auspices of the department of plant breeding, of Cornell University The topics of the lectures follow

Elementary and collective species in nature
Evidences of mutation in plants and animals
The behavior of mutations and elementary species in inheritance
The critics of the mutation theory
The most recent investigations of variation and heredity in *Œnothera*

M Emil Boutroux, professor of philosophy at Paris, has been appointed Herbert Spencer lecturer at the University of Oxford for the present year A Romanes lecturer at the university has not been appointed, the income having been transferred to the emergency relief fund of the university

Mr Stephen Paget is preparing a biography of the late Sir Victor Horsley, the distinguished English surgeon

Dr Bert H Bailey, since 1900 professor of zoology at Coe College died on June 22, aged forty two years

Dr Joseph Weinstein, an instructor in chemistry at Columbia University, died recently in the laboratory of the university He was fifty five years old an analytical chemist and was graduated from the College of Physicians and Surgeons, Columbia University

Sir William D Niven, F R S, formerly director of studies at the Royal Naval College, Greenwich, died on May 29, at the age of seventy five years

Dr William Henry Besant, F R S, fellow of St John's College and lecturer on mathematics, died on June 2, in his eighty ninth year

The annual meeting of the Society for the Promotion of Engineering Education will be held in Washington, D C, on July 6 and 7 in connection with the educational committee of the advisory commission of the Council of National Defense, instead of in the northwest as formerly planned The topic which will be discussed at this meeting is 'The relation of the engineering school to the national government during the present emergency" F L Bishop is secretary of the society

Captain Robert A Bartlett, on June 30, telegraphed to the American Museum of Natural History from St Johns, Newfoundland, that he had taken command of the steam sealer *Neptune* at that port, and that early on July 1 he would steam for Sydney, C B The eight tons of supplies shipped from New York for the Crocker Land party are at Sydney and will there be stowed on the *Neptune* Captain Bartlett expects to leave Sydney on either the third or fourth of July for Etah, Greenland, where the Crocker Land Expedition is now quartered Coincident with the leaving of the *Neptune*, a special display devoted to the Crocker Land Expedition has been installed on the first floor of the American Museum of Natural History The location of the expedition, as well as the probable course of its return is indicated on a globe This exhibition also includes pictures of the vessels which have been sent to the rescue of the party—the *Neptune* being the third There is also on view a canoe of skin, the kyak, in which Dr Harrison J Hunt, a member of the party, who arrived a few days ago, made part of his perilous journey from the base at Greenland to civilization

The government of the Union of South Africa has appointed an advisory board to deal with the development of the natural resources of the country A special scientific and technical committee has been appointed to carry out scientific investigations. This committee consists of Mr. J. Burtt-Davy (botany and agriculture); Mr. L. Colquhoun (chemistry); Professor Young (geology); Professor Orr (mechanical engineering); Mr. Bernard Price (electrical engineering); Professor Beattie (physics); Dr. Caldecott (metallurgy); Professor van der Riet (chemistry); Professor Malherbe (chemistry); Dr. L. Peringuey (president of the Royal Society of South Africa). The first step taken by the new committee has been to arrange for the preparation of fifty-two reports by leading experts, dealing with the available raw materials of South Africa suitable for manufacture or export. It is intended that these reports shall be published for the guidance of intending manufacturers and other business men.

ARRANGEMENTS have recently been completed for the establishment of a new department of technical optics in connection with the Imperial College of Science and Technology at South Kensington. According to a statement in the London *Times*, the new department is under the management of a Technical Optics Committee, of which Mr. Arthur H. D. Acland is chairman, and which at present consists of 18 members representing the Admiralty, the Army Council, the Ministry of Munitions, the Royal Society, the National Physical Laboratory, employers in the optical trades, glass manufacturers and the Imperial College; while two further members have yet to be elected representative of glass workers and metal workers. Mr. Frederic J. Cheshire has been appointed head of the new department at the Imperial College for a period of five years, with the title of director of technical optics and professor of technical optics at the Imperial College. Mr. Cheshire has been associated with optical instruments for many years at the Patent Office, and, since the formation of the Ministry of Munitions, has been deputy director-general of the ministry and technical director of the optical department. He is president of the Optical Society. It is anticipated that the organization of departments will be rapidly completed, and that training will begin at an early date.

UNIVERSITY AND EDUCATIONAL NEWS

PLANS for medical work at the University of Chicago, for which a fund of $5,500,000 has been raised, contemplate two medical schools and provision for research. One medical school on essentially the same basis as that of the Johns Hopkins University is to provide training for candidates for the degree of M.D. The other school, in connection with the Presbyterian Hospital, is intended for the benefit of those in actual practise. It may be estimated that the entire amount of money involved, including all the corporations which unite for this work, will reach approximately $15,000,000.

MR. LEVI BARBOUR, of Detroit, has given $150,000 to the University of Michigan, one hundred thousand dollars of which is to be used for a residence hall for women and fifty thousand for scholarships for women from oriental countries.

As the result of recent gifts, Lawrence College, Appleton, Wis., is erecting a dormitory for women to cost $125,000 and a chapel to cost $120,000.

DR. JESSE MORE GREENMAN, associate professor in the Henry Shaw School of Botany of Washington University and curator of the herbarium of the Missouri Botanical Garden has been promoted to a professorship of botany in Washington University.

AT the recent commencement of Syracuse University, Dr. Louis M. Hickernell was promoted from an instructorship to be assistant professor of zoology. Mr. Harry S. Pizer, B.Sc., won a teaching fellowship in zoology for the coming year.

DR. A. E. SHIPLEY, master of Christ's College, Cambridge, and reader in zoology in the university, has been elected vice-chancellor for the next academical year.

DISCUSSION AND CORRESPONDENCE

AN INSTITUTE FOR THE HISTORY OF SCIENCE AND CIVILIZATION

TO THE EDITOR OF SCIENCE: Dr. Sarton's plan for an *Institute for the History of Sci-*

ence and Civilization is one of the most important and fruitful suggestions that have been made for the advancement of knowledge It is to be hoped that the realization of his idea might come soon and not have to wait until that rather indefinite time—"after the war" As Dr Sarton very properly points out, it would be particularly important and fitting if this institute would be founded in this country *at this time* That the United States, since he wrote his communication, has entered the war should make no difference. We are, as I understand it fighting for internationalism and the founding of the institute now would emphasize the international spirit of American science.

What most particularly interests me in Dr Sarton's plan is the place he gives to Bibliography Some readers of SCIENCE will perhaps remember a couple of communications that the present writer sent to this journal now many years ago on the subject of a proposition for an *Institute for Bibliographical Research* The two ideas should be combined A third idea might perhaps be added to this combination, namely the plan for a lending library for libraries consisting of large and expensive works, chiefly periodicals, transactions and collections, just the kind of publications that the Institute would need for the proper carrying on of its researches, that the collections of such a library would have to be made available to students all over the country should make no difference, it would emphasize the national character of the Institute

Now, as to Bibliography, one of the first duties of the Institute would be to prepare an adequate and as far as possible, complete bibliography of the history of science. The "List of Books on the History of Science," with its Supplement and its companion "List of Books on the History of Industry," published by The John Crerar Library, is merely a bringing together of the material, and only part of the material, for such a bibliography Furthermore, bibliographical research must be one of the principal methods of study in the institute There should be a separate, specially organized, division for Bibliography, the function of which should be not only to carry on bibliographical research and publication, but to give those who come to the institute what they do not seem to get in American universities, a much needed training in the technique of bibliographical compilation and recording It is not uncommon to find otherwise well equipped scholars totally incapable, apparently, of making bibliographical references in a consistent and systematic way, though thoroughly familiar with the bibliography of their subjects and its byways. Those who are interested in a few examples will find them in an article by the present writer in volume 7 of the Papers of the Bibliographical Society of America, entitled ' Efficiency and Bibliographical Research"

AKSEL G S JOSEPHSON
THE JOHN CRERAR LIBRARY

POPULAR NAMES OF PLANTS

TO THE EDITOR OF SCIENCE My attention was recently called to an article in your issue of February 2 concerning popular names of North American plants I especially noted the following sentence

> It is clear, however, that pupils in the public schools, as well as many of their teachers, do not take any interest in or remember the Latin names of plants This being so, it is highly desirable that every species of plant inhabiting the United States and Canada should have an English name It is further desirable that the name should not be a local one

Several years ago when acting as editor in chief of *The Nature Study Review,* I took interest in this question of popular names of plants and discussed it with many competent teachers of nature study I was forced to the conclusion that in a large number of cases it is possible and highly desirable that we should make the English out of the generic names It is my observation that children learn these names quite as easily as they do English names with which they are not already familiar It is nonsense to claim that children can not learn scientific names, for example, chrysanthemum and hippopotamus As examples of familiar plants which are very generally known by their scientific names or by slight modifications thereof, I cite the following list: cosmos, centaurea, aster, alyssum, ageratum, dahlia, canna, petunia, portulaca, primula (primrose), salvia, verbena, zinnia, impatiens, rosa (rose), gaillardia, heliotropium (heliotrope), lobelia, lilium (lily), magnolia, hyacinthus, chrysanthemum, anemone, oxalis, wistaria, clematis, iris, spirea, pæonia (peony), forsythia, phlox, gladiolus, begonia, asparagus, arbutus, coreopsis, smilax, trillium, viola (violet), geranium, fuchsia, tulipa (tulip), catalpa.

The suggestion that a species of *Erechtites* be called white fireweed and one of *Epilobium* be purple fireweed shows the absurdity of trying to standardize local names, for there are white species of *Epilobium*. I am sure that it is easier for school children to learn this scientific name qualified by white or purple.

There are some interesting popular confusions of scientific terms, *e. g.*, syringa is a popular name but unfortunately has become attached to mock orange (*Philadelphus*) instead of correctly to lilac, which as an English name has been applied to various kinds of shrubs.

M. A. BIGELOW

QUOTATIONS

TECHNICAL COLLEGE GRADUATES IN WAR TIME

ONE of the first effects of the entry of America into the war has been the volunteering of the graduating classes, nearly en masse, throughout the country, into national defense service, with a considerable number of enlistments also in junior classes. This dedication of our trained youth for the maintenance of justice against brute-strength aggression is an admirable thing, and no one who believes in the ideals of young men will oppose it. It is important to remember, however, that injudicious dedication to the world's good may actually do the world harm, and well-intended action may by over-haste defeat its own purpose.

War is a vast country-wide engineering enterprise. Theoretically speaking, an all-wise and powerful board of experts should determine where each man and woman should be posted in the great war chain of fighters, for it is obvious that all specially trained men, and particularly all technically trained men, should keep at the posts where their training is needed. It was an inevitable mistake made by our allies at an earlier stage in the war which led many young physicians, engineers, mechanics and valuable specialists to rush as volunteers for the front. It may overtax human intelligence to decide whether any particular man of military age is more needed at the front or at the rear. Mistakes must occur, and many of them; but the technically trained men should be kept at their profession unless there happens to be a superfluity of them. So long as there are earnestness and determination to serve, they also serve who only stand and wait. The junior men in colleges, and particularly in technical or medical colleges, will probably serve their country better by working hard at their educational preparation than by abandoning their college work before their training is completed. In general, however, every day's work done in any sort of productive employment contributes to the war and therefore hastens the end of the war. To do any useful thing hard is to fight for the Allies.—*The Electrical World.*

DISCOVERIES AND INVENTIONS

THE fact can scarcely be reiterated too frequently that the government should extend patronage to scientific investigations and mechanical inventions. Such a step is necessary to promote the arts and industries as well as to safeguard the nation in war. The United States can no longer proceed on a policy of bungling and neglect. Even the Naval Consulting Board is inadequate to the needs of the present emergency. The ability of its individual members is high, but the number of problems to which the board can give its attention is limited by the restricted membership.

The problems taken up by these most competent experts are undoubtedly the most urgent, but even on these particular problems the country is not receiving the benefit of all of the ideas worth considering. Independent inventors are reluctant to contribute the fruits of their efforts through a board whose members are identified with large industrial concerns. Unfortunately the sad story of the inventor who receives no compensation for his discoveries is only too well known. He lacks the means for proper experimentation, as well as for manufacture, and to obtain aid of the capitalist he has to mortgage his prospects too heavily.

A correspondent has suggested that prizes should be offered to stimulate individual enterprise, but only investigators having private means would be in a position to compete for such prizes. It would be a better plan for the government to offer scholarships and to maintain extensive research laboratories and shops where experimental work could be done on a large scale. The work of thousands of inventors is entirely wasted not only because of duplication, but because they are compelled to abandon their investigations after making some discoveries of more or less potential value. If records of their work were preserved a new epoch in the advancement of science might be inaugurated.

On April 2, W. H. Fauber, of Brooklyn, addressed a paper to the board of governors of the Aero Club of America advocating the creation of a government board of invention and research in aeronautics. He also called attention to the fact that it takes so long to adjudicate a patent that the inventor is apt to die during the process, and that an invention really is not protected unless it is in the hands of a powerful corporation.—The New York *Evening Sun*.

SCIENTIFIC BOOKS

BOOKS ON FOOD

William M. Bayliss, the celebrated English physiologist, has written a small volume entitled "The Physiology of Food and Economy in Diet" (Longmans, Green and Co., 1917). In a hundred pages he presents in clear, concise and fascinating language the fundamental principles of nutrition. Bayliss, though noted for his work on the secretory glands and not recognized as an expert on nutrition, has nevertheless written with the appreciative touch characteristic of the master mind.

Miss Winifred Stuart Gibbs, the supervisor of home economics of the New York Association for Improving the Condition of the Poor, has made a valuable contribution to the food problem in "The Minimum Cost of Living" (The Macmillan Co., 1917). The income and expense accounts of seventy-five families receiving charitable aid, in the form both of advice and of money, were analyzed. A food allowance made up from twenty-two items in quantities calculated to suffice for the maintenance of the family, as constituted, gave very successful results. The author states: "Any one who has had experience in working with the tenement population knows how intimate a connection exists between food and the more common diseases of poverty." Thus, before the allowance was granted, record after record read, "children anemic," or "mother suffering from malnutrition." But the allowance of a minimum standard laid the foundation of good health. "Such a sum can restore shattered nerves and renew courage for a mother who has been harassed by irregular and uncertain payments of an income inadequate at best. Such an assured minimum can change pale, listless children into rosy-cheeked romping boys and girls." The "unit" of value for food per "man" per day was taken at 3,000 calories and cost on October 1, 1916, thirty-four cents. Children were rated according to their ages at various fractions of a "man." These latter values appear to be minima. The book tells of an inspiring deed of good work.

Another book, "Food for the Worker," by Miss Frances Stern and Miss Gertrude T. Spitz, with a foreword by Lafayette B. Mendel (Whitcomb and Barrows, 1917), should fill a great need at the present time. In this volume are found 120 household receipts, with their food values, and the arrangement of these recipes into different menus of balanced rations for use during a period of forty-nine days or seven weeks. It should be of aid to any economical housewife, although it aims specifically [illegible] requirement of a family [illegible] children whose ages [illegible] teen. The diet pro- [illegible] contains 375 grams of [illegible] dollar and six cents per [illegible]. Of this, twenty-four per [illegible] bread, thirteen per cent. for [illegible] for meat, and the rest [illegible] articles. The bread ration [illegible] or 35 per cent. of the [illegible] of the food. This kind of [illegible] highest value to the house- [illegible] and can be successfully [illegible] t person.

[illegible] Manual," by Miss Mary [illegible] and Company, 1916), [illegible] which is a delight, mod- [illegible] knowledge helpful in [illegible] environment for the [illegible] the care, nutrition and [illegible] child.

GRAHAM LUSK

[illegible] ARTICLES

[illegible] AS STATED IN TERMS OF [illegible] STUDIES ON PIGEONS[1]

[illegible] meeting of this society, in [illegible] made known the fact that the [illegible] had been experimentally con- [illegible] Whitman. The main fact [illegible] briefly that from a family [illegible] only males, and from a generic [illegible] all males, are produced; but if, by [illegible] the birds of generic crosses are [illegible] reproductive overwork then [illegible] of such a series produce mostly [illegible], while the later eggs—from the [illegible]—will produce mostly or only [illegible] the same time and place I made [illegible] a first report upon the nature of [illegible] my own studies upon the ova of [illegible] controlled series. These re- [illegible]—to quote from the pub- [illegible] of that paper[2]—

that eggs (yolks) of *smaller size, higher water-content* and *smaller energy-content* (i. e., fewer units of physiologically available energy) can be *correlated* with *maleness* in the offspring. That eggs (yolks) of *larger size, lower water-content* and *greater energy-content* can be *correlated* with *femaleness* in the offspring.

The later results, which I have from time to time presented before this society and elsewhere, have fully confirmed and much extended the evidence for that early announcement of the nature of the germinal differences which characterize the two sexes.

Though all of the several lines of study that I have carried out on the doves and pigeons have thrown light on the *nature* of germinal and adult sexual difference most of these lines of study were primarily designed to test the possibilities of selective fertilization, differential maturation and elective elimination of ova in the ovary as alternatives of a true sex-reversal or control. In view of the well-established fact that the hetero-gametic sex produces germs of two kinds—a sex-chromosome being a differential already recognized—it has seemed obligatory to supply decisive tests for the possibilities just named. This has all been thoroughly done in the pigeons; the result has been made possible because the female here is the hetero-gametic sex, producing male and female ova, and we have here learned to identify each of the two kinds. In these forms Whitman controlled sex and clearly demonstrated the methods of control. In these same forms I have for six years repeated the control and fully confirmed the method. In addition I have obtained adequate proof of the reality of the sex-control as against the above-mentioned alternatives and have further shown that in this material sex is a matter of essentially *all* gradations. And, of signal and unique importance is the fact that all, or at least many, gradations of sex are obtained from the same pairs of parents. The *outlines* of these findings have been published in several short papers beginning in 1911:[3] the entire body of evidence is now in course of preparation for publication. A still further fact of high importance has been learned from the pigeons, namely, that the sexual differences of the germs persist into the adult stages of the two sexes.

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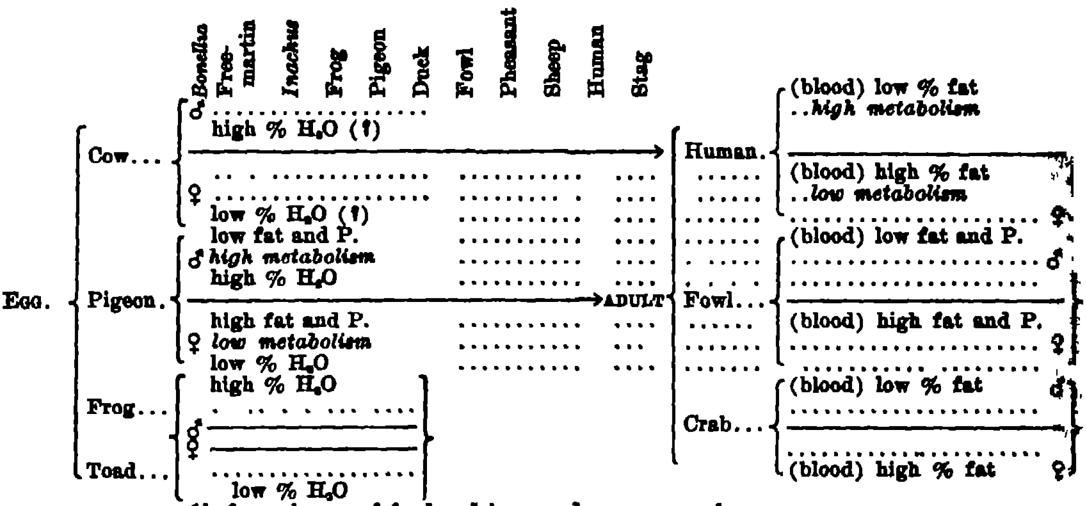
[1] [illegible] December 28, 1916, before the [illegible] of Zoologists (New York Meeting).

[2] [illegible] Vol. XXV., No. 899, pp. 462– [illegible]

[3] See under note 2; and, Carnegie Year Book, 1913; SCIENCE, Vol. 39, 1914; *Bull. Amer Acad. of Med.*, Vol. XV., 1914; *Amer. Nat*, Vol. L., July, 1916.

DIAGRAM



Hydatina ..... { ♂'s from change of food and *increased* oxygen supply.
♀'s from *unchanged* food and *lesser* oxygen supply.

Daphnids ..... { sex-intermediates,—sexual or asex. reprod. influenced by conditions.

Moths .... { sex-intermediates,—quantitative germinal basis of sex.

Again, since my first report of these results, several studies by other investigators on several different groups of animals, have appeared which in a most gratifying manner confirm the point of view of my first communication, and afford further evidence for the control and modifiability of sex.

It is the purpose of this paper to arrange some of the results of studies on the pigeon in a diagram, upon which are properly placed these various results of other investigators of sex, in order to show that we are already in possession of the skeleton of fact which is necessary for a theory of sex that accords with the most important fact of sex-reversal and control. And, that the theory of sex must be restated—or rather may now be stated—in terms that accord with the facts of sex-reversal is as certain as is the fact of sex-reversal itself. After our demonstration of the reality of sex-reversal in doves and pigeons—even there had been a complete lack of corroborative evi in other forms—the problem of the ulti basis of sex was effectively broken loose the morphological moorings which a deca increasing knowledge of the sex-chromos had, to a considerable extent, fastened it. For, at the same time that it was proved that ou *experimental* conditions break the correlatio which *normally* certainly does obtain be tween the chromosomal constitution of th zygote and the prospective sex of the adult, i was possible to identify those *functional* corre lations which here continue to exist (as in th normal cases) and mark off the differences be tween the germs of prospectively different sex-value. We know, till now, of no other materia in which this basal persistent function has been definitely identified and quantitatively measured in the germ. As I have elsewhere pointed out, the basic fact is that the two kinds of germs are differentiated by the degree or level of their metabolism. When either of these two kinds of germs is forced experimentally into the production of the opposite sex, the lèvel of its metabolism is shifted to the level characteristic of the germs of that oppothe sex. While the chromosomal correlation is be forced to failure the metabolic correlation here persists. The chromosomal constitution is not an efficient cause of sex; it is but sign or index[4] and possibly an assistance in the *normal* maintenance of that which is essential—namely, two different metabolic levels. That the requisite metabolic level of the germ may be established in the absence of the usual or appropriate chromosome complex, and the sex of the offspring made to correspond to the acquired grade or level of metabolism.

These facts which we consider firmly established in the pigeons carry the further *essential* analysis of sex practically into the field of physiology and bio-chemistry. Further analysis of the basis of sexual difference—in germ or in adult—is to be sought in studies of the metabolic differences of the two kinds of sex-germs, of adults of the two sexes, and of individuals of intermediate sex. Now that the problem of sex has been shown to belong in the field of metabolism we shall be able to note, in connection with our diagram, that a number of the requisite data bearing on germinal and adult sexual differences are already at hand.

Turning now to the diagram we note that *egg* and *adult* stages are considered. In the egg of the pigeon we have identified maleness and femaleness by three differentials. Femaleness in the egg stage being accompanied by *low metabolism,* lower percentage of H_2O, and higher total fat and phosphorus, or of phosphatides. Maleness is here accompanied by *high metabolism,* higher percentage of water, and lower total fat and phosphatides. Now there are valid reasons for treating these three differentials not as absolutely separate and disconnected facts, but rather as aspects or corollaries of the same fact. For example, a *high metabolism* in a cell is consonant with less storage of fat and phosphatides, and with a more highly *hydrated* state of the cell-colloids. It follows that where data for either of these three differentials are at hand, for either the germ or adult of any animal, we have in such data evidence of the kind we are looking for, *i. e.,* evidence for the association of a given type of metabolism with the germ or adult of a given sex.

TABLE I

Sexual Differences of Fat and Phosphorus in the Blood of Adult Fowls and Man

Sex	Av Total Fat	Av Total P	Ratio P.
Males (roosters)	15 45	6.43	100
Non-laying females. ..	17.87	7.42	115
Laying females .	27 80	13.15	205
Males (man) . .	141.4		
Females (woman) .	226 0		

For what forms then are such data available? And, what is now known of the persistence of this definite type of differentiation of the two kinds of sex-germs into adult stages of the two sexes? Recently Lawrence and Riddle[5] have shown that one of these differentials—or one aspect of *the* differential which my own work has demonstrated in the egg—is clearly continued in the *blood* of the adult male and female (see Table I.). Fowls were substituted for doves in this case in order to increase the size of the sample, and thus increase the accuracy of the analytical results. In birds, therefore, we have fairly clear evidence that the metabolic differences of male and female germs persist in the male and female adults. In mammals too these aspects of sexual differences of the adults have been fully demonstrated. Almost simultaneously with the above determinations, data were published by Goettler and Baker,[6] which as we have pointed out, show that the blood of the human male contains less fat, that of the female more.[7] Further, the *basal metabolism* of the human male and female has recently been accurately determined by Benedict and Emmes;[8] they find that the metabolism of man is 5 per cent. to 6 per cent. higher than that of woman.

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[4] Since the chromosomes are *structural* characters they can not be expected readily to *alter* their numbers, etc., in response to new quantitative levels attained (permanently) by the fundamental *cell-functions.*

[5] "Sexual Differences in the Fat and Phosphorous Content of the Blood of Fowls," *Amer. Jour. of Phys.,* Vol. XLI., September, 1916.

[6] *Jour. Biol. Chem.,* XXV., June, 1916.

[7] This result seems to have been anticipated by Gorup-Besanez in 1878.

Have we any measure of either of our differentials in any mammalian egg? I think that the experiments on sex-determination in cattle, together with an observation by van der Stricht, afford some evidence that the water-content of the male-producing egg is high, and that of the female-producing egg is low. Thury reported in 1862 that from fertilizations made in the early period of heat in cattle an excess of females were produced; and that later (delayed) fertilizations give rise to an excess of males. Similar experiments have been four or five times repeated by others, and these have all shown an excess of one or the other sex in accordance with such early or late fertilization.[9] No one definitely knows whether the ovum of the cow absorbs water in the Fallopian tubes in this interval between ovulation and fertilization, but we do know that every amphibian, reptilian and avian egg that has been investigated does absorb very appreciable amounts of water while being passed from the ovary to the exterior. And, van der Stricht has described phenomena of growth or swelling of the yoke granules in one mammal—the bat—which, I am sure from my own studies on yolk, indicate the taking up of water by the egg of this mammal. It is highly probable, therefore, that precisely that *time relation* which leads to an excess of males in cattle is preceded or accompanied by an increased hydration of the ovum. In mammals therefore there is some evidence that a shift of the metabolic level—as indicated by one partly known sex-differential—is associated with the observed changes in the sex-ratio of the germs which are thus modified. Further, in one adult mammal—man—two of the three sex-differentials have been definitely demonstrated. These results for both the egg and adult stages of the mammal are at every point in complete agreement with our data for both the egg and adult stages of the bird.

Experiments on the frog and the toad have afforded evidence for the control of sex. This evidence by many is not thought conclusive. Though selective fertilization has been eliminated as a possibility by Kuschekewitch there remains the possibility of parthenogenetic development to account for the excessive male-production in his experiments with the frog. But this appeal makes it impossible to explain the great excess of *females* obtained by Dr. King on the eggs of the toad, and leaves such doubters to lean here upon the discredited staff of selective fertilization—a proposition wholly disproved for the related frog and for the pigeon.

How does this situation look in the light of the sex-differentials already noted for birds and mammals? Richard Hertwig,[10] and later Kuschekewitch,[11] allowed frog's eggs to over-ripen—a process during which *the eggs take up water*—and obtained (in the case of the latter author) in some cases a total of 100 per cent. of males. Dr. King[12] did the converse of this experiment with toad's eggs—*withdrawing water* from them before fertilization—and obtained nearly or quite 90 per cent. of females in cases where the mortality was less than 7 per cent. According to our knowledge of the sex-differentials in the pigeon's eggs both of these experiments might have been predicted to result as these three investigators have reported.

In the spider-crabs Geoffrey Smith[13] has shown that both the blood and the liver of the adult male crabs contain less fat than do the blood and liver of the females. Here once more the facts concerning one of the sex-differentials is in complete accord with all the preceding cases. In the parasitically castrated spider-crabs Smith and Robson were able to show, moreover, that *the parasitized male crabs, which under these conditions gradually assume several female morphological character-*

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[8] *Jour. Biol. Chem.*, Vol XX, 1915. These authors give references to earlier literature.

[9] The use of the terms *early* and *late* fertilizations assumes that some ovulation occurs either immediately before, or shortly after, the beginning of heat.

[10] *Verhand. deutsch. zool. Gesellsch.*, 1906.

[11] *Festschrift. f. R. Hertwig*, 1910.

[12] *Jour. of Exp. Zool.*, Vol. 12, April, 1912.

[13] *The Quart. Jour. of Micr. Sci.*, Vol. 57, November, 1911.

istics, are also found to have assumed the type of fat metabolism which characterizes the normal female crab. How much these facts contribute to, and how completely they adjust themselves to, our own general theory, will be realized only after a moment's reflection.

A glance at the diagram indicates three other groups of animals which experimental work has thrown into the general question of the control of sex. The information at hand for these forms does not so expressly concern the *egg* as does that from the preceding cases, but all of these latter groups are concerned with early stages—some of them with the generation preceding the egg whose sex seems influenced by conditions. The results of studies of the first of these groups—*Hydatina*—are of such a kind as to show that they are in general accord with the metabolic differentials of all of the previously mentioned cases of sex-control. One can scarcely doubt that *change* of food, and *increased oxygen* supply are consonant with increased metabolism, just as the studies of Whitney[14] particularly, and later of Shull,[15] have shown that these changes lead to the appearance of male-producing daughters.

The second of these groups—the Daphnids—have been studied by three independent investigators who agree upon two points that are of importance in the question of the control of sex, and to the general theory of sex as stated here, though the results throw little light on precisely what is causally involved. Issakowitch,[16] Woltereck[17] and Banta,[18] all find numerous *sex-intermediates* in a material for which all agree that the type of reproduction—sexual or asexual—is influenced by environmental conditions. All further agree that "unfavorable conditions" (or is it a *change* from favorable conditions?) tends toward *sexual* reproduction, while "favorable conditions" favor asexual reproduction.

In the third of these groups—the moths—the studies of Goldschmidt, and Goldschmidt and Poppelbaum,[19] and the work of Machida, have demonstrated again sex-intermediates of various grades. Moreover, it has been shown that from among the various geographical races of moths certain matings can be arranged which produce rather definite types of male- or female-intermediates—or sex-intergrades, as Goldschmidt elects to call them. And further, from pairs involving still other species still other levels or grades of sex-intermediates may be freely obtained. A more or less factorial basis of the phenomena has hitherto been used in the discussion of these results; but recently Goldschmidt[20] has stated that "very important new facts will be published later which will probably enable us to replace the symbolistic Mendelian language, used here, by more definite physico-chemical conceptions." Such newer descriptions—we would say—is wholly in line with the requirements of present data on sex. In Whitman's and our own material it has been clear from the first that the results far overstep the possibility of treating them in Mendelian terms, for it has been apparent from the beginning that we have had to do not with three or four *points* merely, but with a *flowing graduated line* In the work with the moths, however, sex is clearly described in *quantitative* terms, and we can readily believe that when the functional basis of sex can there be identified, sex will be found to accord with metabolic grades there, as it does elsewhere.

It is clear then that all of the animal-forms for which there is reasonable evidence of sex-control show important correspondences with the situation fully elucidated in the pigeons. And that where the sex-differentials known to exist in the pigeon's ova have been traced in adults of the two sexes, the parallel rigorously holds there also. A general classification of male and female adult animals on the basis of a higher metabolism for the one, and a lower for the other, was indeed made by Geddes and Thomson[21] many years ago. There can now be little question that this conclusion of these authors is a correct and important one.

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[14] SCIENCE, N. S., Vol. 39, June 5, pp. 832–33, 1914. Also *Jour. Exp. Zool.*, Vol. 17, November, 1914, and later papers.

[15] Abstracts of Amer. Soc Zool., December meeting, SCIENCE, N. S., Vol. 43, 1916.

[16] *Biol. Centralbl*, Vol. 25, 1905.

[17] *Intern. Rev. d. gesammt. Hydrobiol. u. Hydrogr.*, Vol. 4, 1911–12.

[18] Carnegie Year Book, 1915, and *Proc. Nat. Acad. Sci.*, Vol. 2, October, 1916.

[19] Goldschmidt u. Poppelbaum, *Ztschr induct. Abstammungsl.*, Vols. VII. (1912), and XII. (1914), and other papers 1913–16 by both authors See R. Goldschmidt, below

[20] R. Goldschmidt, *Amer. Nat.*, Vol. L., December, 1916.

It remains to point out that another very old, and much-worked line of investigation supplies further confirmatory evidence for our present point of view. Studies on the effects of castration, gonad-transplantation, and gonad-extract injection, constitute a large body of observations which deal with sexual phenomena associated with the *internal secretions* of the sex-glands. These internal secretions, let it be remembered, are themselves *metabolites,* which have the capacity to *influence the metabolism* of some, many, or of all the tissues with which they came in contact, or which they may reach indirectly. A partial list of the animal forms that have been most studied in this respect is written vertically on the top of our diagram—in a position intermediate to egg and adult. The number of these animal forms might be much increased, and the names of the investigators of this aspect of the modification of sex are quite too numerous[22] to be mentioned here. But the present point of interest is that these results, as a whole, demonstrate that *the extent of sexual modification in the experimental animal is, in general, in proportion to the immaturity of the treated animal.* That is to say, the earlier the internal secretion of the gonad is supplied or withdrawn, the more profound is the sexual modification of the individual. The stag is a form that has long been known to show thus a considerable and beautiful series. The free-martin—another Ungulate—is now known to exemplify a much earlier point at which the foreign internal secretion begins to act; and here, true to the rule that has been established elsewhere in all this general line of work, the resulting modification is correspondingly strong and striking. When, by whatever means, we effect a change in the metabolism (which is the essential thing) at a still earlier stage—in the egg-stage, in our own and in some other experimental reversals of sex,—then we obtain individuals whose sexual nature is quite thoroughly reversed; in many cases completely so, and in still other cases with varying degrees of completeness.

Professor Whitman's main decisions concerning the *nature* of sex may here be briefly stated. These decisions were that the male proceeds from a "stronger" germ, has greater "developmental energy," and "carries the processes of development farther" than does the female. I am confident that his results fully justify his conclusions; and that these are in the completest harmony with the later and fuller developments of the sex-studies in the pigeons, and thus with the theory of sex which has been outlined in these pages.

In conclusion, our present definite knowledge of the metabolic basis of sexual difference, and the methods of attack which this new knowledge brings with it, offer the surest guarantees that the problem of sex can now be studied—and, indeed, the basal facts of the problem must be studied—in the field of the elemental protoplasmic functions.

OSCAR RIDDLE

COLD SPRING HARBOR, N. Y.

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[21] "The Evolution of Sex," 1890, Humboldt Publ'g Co., New York.

[22] The following partial references are suggested by the particular animals listed in the diagram: *Stag*—Darwin (1868); Caton (1881); Fowler (1894); Rörig (1900). *Human*—Hegar (1893); Selheim (1898); Hikmet and Renault (1906); C. Wallace (1907); Tandler and Gross (1909). *Sheep*—Shattock and Seligman (1904); Seligman (1906); Marshall and Hammond (1914). *Guinea-pig*—Bouin and Ancel (1903–09); Steinach (1910–13). *Pheasant*—Gurney (1888). *Fowl* and *Duck*—Darwin (1868); Gurney (1888); Foges (1903); Shattock and Seligman (1906–07); Goodale (1910–16). *Pigeon*—Riddle (1914). *Frog*—Nussbaum (1907); Pflüger (1907); Steinach (1910); G. Smith (1912). *Inachus* and *Carcinus*—Potts (1909); G. Smith (1910–12). *Free-martin*—Lillie (1916). *Bonellia*—Baltzer (1914).

SCIENCE

FRIDAY, JULY 13, 1917.

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

PHYSICAL CHEMISTRY IN THE SERVICE OF PHYTOGEOGRAPHY[1]

BIOLOGISTS, grown in the present generation from a mere squad of determined scouts to a splendid army of disciplined investigators, increasing daily in rank and equipment, have as their greatest task the placing of biology alongside physics and chemistry in the ranks of the exact sciences.

In the title of this paper, *Phytogeography,* which even its most ardent disciples must confess is one of the least quantitative of the biological sciences, is coupled with *Physical Chemistry,* which is conceded by all to be one of the most precise of the physical sciences. This contrast has been made, not to magnify the chasm which conventionally has been assumed to separate the exact from the descriptive sciences, but to emphasize to biologists and to chemists and to physicists alike, the fact that the methods of the most advanced physical sciences can now be successfully employed in such a confessedly descriptive phase of biology as ecology and phytogeography.

In turning to the task of the moment, which is to consider how certain of the simplest physico-chemical methods may be of service in ecology and phytogeography, it is important to place the group of problems to be investigated in its proper biological setting, and to state these problems in such a form that their relationship to a physico-chemical method of investigation is quite obvious.

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[1] A paper presented at the Symposium on Relations of Chemistry to Botany, before the joint session of Section G, American Association for the Advancement of Science, and the Botanical Society of America, December 27, 1916.

Phytogeography has two main phases, the historical and the physiological.

In the investigation of the historical factors involved in the geographical distribution of plants, the methods of physical chemistry can be of little service.

The physiological problems of ecology and phytogeography are essentially those of the relation of the organism to its environment. It is here that physical chemistry, along with other quantitative and experimental methods of research may be profitably applied.

It is a truism to say that the relations of the living protoplasm to its inert environment constitutes one of the most fundamental groups of biological problems. To cooperate in the solution of these problems is the greatest opportunity of ecologists. That the contribution of ecology has not already been greater is largely attributable to the non-quantitative character of most of the work hitherto done.

In the closer analysis of the relationship of the organism to its surroundings it is apparent that there are two planes of contact of protoplast and environment: that which lies between the protoplast and separates it from the outside world, and that which lines the vacuoles of the cell and separates the deeper-lying protoplasm from the internal environment of the vacuolar solution, just as the plasma membrane separates it from the external world.

The processes which are taking place in these two planes are presumably physicochemical processes. Certainly, physicochemical methods of investigation are those which may be applied with the greatest hope of advance in the solution of the problems presented by those planes of contact of organism and environment.

That these processes are of fundamental significance to the student of the complex problems of ecology and phytogeography of the higher plants should be evident from the fact that the differentiation of tissues in the vast majority of flowering plants, with which alone I am concerned in this paper, is such that the cell membrane comes into contact with two quite distinct phases of the environment. In water absorption, it separates the fluids of the cell from a soil solution of quite different properties. In water loss, it separates the fluids of another set of cells from an atmosphere varying enormously in its water absorbing capacity.

These two environmental factors, which stated in physiological terms may be referred to as the force with which the substratum withholds water from the plant and the force with which the atmosphere tends to withdraw water from the plant, have by common consent been given the place of first importance in the environmental complex.

The importance of a thoroughgoing investigation of the relationship of the plasma membrane to the concentration and the composition of the intracellular and the extracellular solution has long been recognized. Nor have physiologists interested in the problem of transpiration failed to recognize the fundamental significance of the membrane which separates the fluid contents of the cell from its gaseous environment.

It is quite natural that the problem of the permeability of the cell membrane should have been far more extensively investigated than that of the relationship of the protoplast to the cell sap. Experimental modification of the solution surrounding the cell is subject to only the limitations imposed by the solubilities and other properties of chemical reagents and the viability under the influence of these reagents of the cells or tissues employed. To determine the properties of the sap contained in the vacuole at any moment is a problem of some difficulty, to modify these properties at will is in itself an undertaking of no mean magnitude, while to investigate with any degree of completeness the relations of the properties of the sap of the vacuoles to the surrounding protoplasm would seem to be a task of almost unsurmountable difficulties.

Nevertheless, the time has come when an investigation of the properties of the sap of the vacuole in relation to the protoplast and in relation to the factors of the environment should be undertaken. It is inconceivable that the properties of the sap should be uninfluenced by the forces which are acting upon and through the living membrane surrounding the cell. It is difficult to think, for example, that the osmotic properties of the sap of the vacuoles should be independent of the forces which are tending to draw water from the cell in transpiration and of the forces in the substratum which oppose water absorption. If this be true, an investigation of the properties of the intracellular fluids of plants in various environments, in which the water-absorbing power of the air as well as the water-yielding capacity of the soil vary enormously, may throw much light upon the basic physiological problems of ecology and plant distribution.

If progress is to be made, it is not merely necessary that problems be clearly defined, but that methods which are adequate and practical for use under the conditions surrounding the investigation shall be found. The question of method becomes, therefore, one of paramount importance.

The phytogeographer must limit his choice to those methods which can be used under camp conditions. Otherwise he must be willing to forego work on phytogeography in the only regions in which it can be satisfactorily investigated, that is, in those which have not been completely modified by the activities of man. Fortunately the determination of the depression of the freezing-point of a solution below that of the pure solvent furnishes a relatively simple method of calculating its osmotic pressure or osmotic concentration. It is quite possible to make cryoscopic determinations sufficiently exact for phytogeographical problems in the field, and especially at the field laboratories which fortunately are becoming more numerous.

In addition to developing a simple technique for use in the field, one who hopes to convince botanists that the investigation of the physico-chemical properties of vegetable saps should form an essential part of a comprehensive ecological or phytogeographical study, must show that in any region the sub-habitats, formations, associations, plant societies or whatever the nomenclatorial specialist may call them, are measurably different in their sap properties, and that even more conspicuous differentiation exists in the sap properties of the larger phytogeographical regions. If he can also show that such ecological groups as the succulents, the epiphytes and the parasites are differentiated in the physico-chemical properties of their tissue fluids, the necessity for the use of physico-chemical methods in phytogeographical work will be self-evident.

The foregoing outline of the fundamental conceptions underlying the studies which my associates and I have carried out in various regions has of necessity been so detailed that it will be impossible at this time to give any adequate summary of the many hundreds of determinations of osmotic concentration of tissue fluids of plants growing in various environments which are now at my disposal.

The actual details, as far as published, are available in a series of technical papers.

How great the differences in the sap properties of the vegetations of various regions may be is illustrated by the accompanying table in which the average concentration in atmospheres for Long Island, Arizona and Jamaican regions studied by my associates and myself and for a series of determinations made for a quite different purpose by Ohlweiler at the Missouri Botanical Garden are laid side by side.

Region	Ligneous Plants	Herbaceous Plants
Montane rain forest:		
Blue Mountains, Jamaica...	11.44	8.80
Mesophytic regions:		
Long Island habitats	14.40	10 41
Missouri Botanical Garden.	14.96	——
Desert regions:		
Jamaican coastal deserts ...	30.05	——
Arizona deserts	24.97	15.15

Had it been possible to table the data of each of these regions, and that for others which are now available, according to local habitats it would have been seen that in any region the local habitats may be measurably differentiated with respect to the sap properties of their vegetation. Tabulation by local habitats would also have brought out clearly the fact that herbaceous and ligneous plants differ in the osmotic properties of their tissue fluids.

The averages in the table are not presented as complete descriptions of the sap of the plants of these regions, but merely as the simplest available means of summarizing their characteristics and emphasizing to the phytogeographer the fact that the vegetations are differentiated in the properties of their sap as well as in their taxonomic composition and ecological structure.

The explanation of such differences in vegetations as have just been demonstrated is by no means simple.

The most direct and obvious relationship of the properties of the sap of the organism to its environment is to be seen in halophytes. The leaves of many of these are salty to the taste. It is quite apparent that they must have a relatively high concentration due to the absorption of salts from the substratum. It is, however, a grave error to assume, as some botanists seem to have done, that the whole problem of sap concentration is one of the absorption of electrolytes from the soil—to assume in fact, that the plant organism stands in the relation of a sponge to the solution around it. Zoologists, who have devoted much attention to the relationship between the concentration of the blood of the marine organisms and that of the water in which they live, have long recognized that the osmotic concentrations of the two fluids may be identical but that the solutes to which these concentrations are due may be very different indeed.

Even in the succulent halophytes, the leaves of which are essentially reinforced water bags, there appears to be by no means an identical capacity for adjustment to the concentration of their substratum or for the occupation of available areas. Thus, for example, *Sesuvium Portulacastrum* and *Batis maritima* both occur on the highly saline flats of the southern shore of the island of Jamaica. *Batis* shows a far higher osmotic concentration than *Sesuvium*, 49.7 as compared with 38.3 atmospheres on the average, and is seen in the obviously more saline localities.

Now differences in the concentration of the soil solution may not be the determining factor in the distribution of these two halophytes. Other factors require far more detailed investigation than any one has been able up to the present time to give them. The point to be emphasized here is that two species of halophytes, not without several points of similarity, differ in both sap concentration and in local distribution. The chemical method has given us at once measures of the physiological characteristics of these two forms. These quantitative measures furnish a first definite step towards the solution of the problem of their distribution.

To discuss adequately the many problems presented by a comparison of the sap properties of the vegetations of diverse local habitats or phytogeographical regions would carry us far beyond the limits of this address. Before leaving this phase of the subject it is important to point out that in its relationship to plant distribution, sap concentration may have a dynamic as well as a static significance.

If the differences in the sap properties of the vegetations of various habitats be in part due to fixed hereditary differences in the species, instead of merely a resultant of local environmental conditions, and if one of the factors determining the capacity for survival in a given habitat be the osmotic concentration of the cell sap, it is clear that sap properties may be a factor in the migration of species.

The factor of osmotic concentration would be active in two ways. First, in the determination of migration from warmer into colder regions, by virtue of capacity for frost resistance. Second, in migration from mesophytic into desert regions.

The problem of the relationship of sap concentration to frost resistance need not delay us long. The freezing-point of plant tissues has been the subject of scores of investigations, most of which have been of a purely physiological or of an economic nature.

The studies of Ohlweiler, Chandler and others render it highly probable that the osmotic concentration of the tissue fluids is one of the factors involved in the capacity for frost resistance. Such determinations as Mr. Popenoe and I have been able to make on the sap of the varieties of avocado (*Persea americana*) which have been introduced into the United States, indicate that the Mexican and Guatamalan types, which have been found by practical horticulturists to surpass the so-called West Indian type in capacity for frost resistance, have a slightly higher osmotic concentration of their cell sap.

Concerning the rôle of osmotic concentration in the survival of plants introduced into xerophytic regions we have as yet practically no information.

It is perhaps evident that the factors which limit the artificial introduction of species would also be active in determining the survival of species introduced into any region by hurricanes, ocean currents or by any other natural causes. Upon some of these questions I hope to be able to furnish more satisfactory information on a later occasion.

We must now turn to a discussion of certain of the ecologically more interesting groups of plants. Among these may be mentioned the succulents, the epiphytes and parasitic plants.

The studies of succulent physiology which have been carried out in recent years, and especially at the Desert Laboratory by MacDougal, Spoehr, Richards, Mrs. Shreve and others, have been far too detailed to make possible any adequate discussion of succulency at this time. It is interesting to note in passing that the succulents are characterized by two quite different types of sap. On the one hand are the desert species with generally low osmotic concentration, on the other the halophytes with high osmotic concentration. The physiological interpretation of this condition presents a most interesting problem for future research.

Among the most characteristic, and ecologically most fascinating features of tropical regions is the burden of epiphytes borne by the trees. If one turns to the literature in search of work of a quantitative nature on the physiology of this taxonomically and morphologically diversified group of plants, his search will be practically in vain. Material progress has already been made in the study of the sap properties of some of the representative types, although it is quite too early to discuss in detail even this phase of the physiology of these plants.

Osmotic concentration in these forms is generally exceedingly low, Orchidaceæ from the Jamaican rain forest show an average of 3.34 atmospheres, those from the Florida hammocks an average of 4.88 atmospheres. Tank epiphytes from the Blue Mountains of Jamaica show concentrations ranging from 2.8 to 5.5 atmospheres. Comparable values are found in subtropical Florida.

The succulent Peperomias and some other epiphytic species are also characterized by a concentration of their tissue fluids only a fraction of that obtaining in the foliage of the arborescent plants of the same forests.

Thus, in general, epiphytic species are characterized by low osmotic concentration. This is not, however, a necessary condition of epiphytism. Determinations are available for at least one species of epiphytic fern showing a sap concentration roughly three times as high as that generally characteristic of the succulent Orchidaceæ and Piperaceæ and the tank Bromeliaceæ.

The keen botanical interest aroused by parasitic flowering plants has found expression in an enormous number of macroscopic and microscopic morphological and life-history investigations. Yet it should be clear that the problem of the distribution of parasitic forms, both among the possible host plants of a particular region and from region to region, is primarily a physiological one. Among the possible factors, the relative concentration of the tissue fluids of the photosynthetic and transpiring organs of the host and parasite seems on *a priori* grounds one of the greatest importance. Studies on the osmotic concentration of the tissue fluids of Jamaican Loranthaceæ on various hosts have shown that in general but not invariably, the osmotic concentration of the fluids of the leaves, or of the leaf homologs, of the parasite is higher than that of those of the host.

In the foregoing discussion only a portion of the results of studies already made, but as yet largely unpublished, have been lightly touched upon. They are illustrative merely. For the mass of facts justifying generalization, the published tables must be consulted. Enough has, perhaps, been said to indicate the fundamental significance for the physiological phases of phytogeography of the physico-chemical measurements. As phytogeography becomes more and more a problem of the physiology of individual species of plants, investigated in their own environment, as methods become more precise, and as results are recorded and discussed in more quantitative terms, the ecologist's sector of the attack upon the great problem of the relationship of the organism to its environment will be increasingly successful. Concurrently, the relations of chemistry to botany will become more clearly defined in a field in which its existence has heretofore been little recognized, and the service of chemistry to botany will be increasingly great.

J. Arthur Harris

SCIENTIFIC EVENTS

MEMORIAL TO SIR WILLIAM RAMSAY

The following appeal has been issued by a committee formed to raise a memorial to the late Sir William Ramsay.

A committee has been formed with the object of raising a suitable memorial to the late Professor Sir William Ramsay, K.C.B., F.R.S., by collecting a substantial fund to be utilized for the purpose of promoting chemical teaching and research.

The committee, after prolonged and careful consideration, has resolved to aim at raising a sum of £100,000, and to devote that sum to two principal objects, viz.:

1. The provision of Ramsay research fellowships, tenable wherever the necessary equipment may be found.

2. The establishment of a Ramsay Memorial Laboratory of Engineering Chemistry in connection with University College, London.

We should hesitate to ask for so large a sum of money in such exceptionally difficult times, were it not that the objects specified are objects of real and urgent national importance. The war has demonstrated in a manner previously unrealized the supreme importance of scientific, and, in particular chemical, research to the national life, both in the conduct of the war and in the pursuits of industry and manufacture.

The late Sir William Ramsay was himself engaged up to within a comparatively short time of his death in various important problems concerned with the bearing of chemistry upon the war, and no one realized more completely than he the potentialities of the plans which have since been formulated by this committee as a memorial to him.

It is important that the fund should be raised speedily, so that the plans for the laboratory of engineering chemistry and the scheme for the award of fellowships may be prepared before the end of the war, and so that both schemes may begin to operate with as little delay as possible after the return of peace.

Accordingly, we desire, through the columns of your paper, to appeal to friends and admirers of the late Sir William Ramsay, to old students, and to all persons who are interested in chemistry and its application to industry and manufacture, to contribute to this great national and international memorial to the late Sir William Ramsay, and to send their subscriptions to the honorable treasurers of the Ramsay Memorial Fund at University College, London, W.C.1.

H. H. Asquith,	*President;*
D. Lloyd George, Gainford, Rayleigh, Bray, Rosebery, H. A. L. Fisher, J. J. Thomson,	*Vice-presidents;*
Hugh Bell,	*Chairman of the Executive Committee;*
Glenconner,	*Treasurer.*

It is stated in *Nature* that the sum already subscribed by Ramsay's friends, and through their private efforts, amounts to more than £14,000. This includes the generous gift of £5,000 from Messrs. Brunner, Mond, Ltd.; £1,000 each from Lord Glenconner, Sir Hugh Bell, Sir Ralph C. Forster, Sir Robert Hadfield, Mr. Robert Mond, and Mr. J. B. Noble; and £500 each from the president of the British Science Guild (Sir William Mather), Mr. Charles Hawksley, and Miss Lilias Noble.

A memorial tablet, including a medallion portrait of Ramsay, is to be erected in the University of Glasgow, of which he was a graduate and teacher. The University Court has arranged that the memorial, which is designed by Sir John J. Burnet, shall be placed in a conspicuous position at the entrance to the Bute Hall

SMITHSONIAN BOTANICAL EXPEDITIONS

A recent pamphlet on the field-work conducted by and for the Smithsonian Institution states that, while carrying on botanical explorations in Venezuela last fall, Dr. J. N. Rose, associate curator of plants in the National Museum, secured some interesting specimens of "sabadilla," a Venezuelan plant of the lily family, from the seeds of which are produced some of the asphyxiating and tear-producing gases used in the present war.

The specimens were secured by Dr. Rose through the cooperation of Consul Homer Brett, La Guaira, Venezuela, who stated in a report of the Department of Commerce, some time ago, that this plant is known locally as "cevadilla," a diminutive of the Spanish word "cebada," meaning barley, and occurs in Venezuela and Mexico. Its highly poisonous seeds have long been used in medicine. The substances produced from sabadilla seed are cevadine, or crystallized veratrin, an alkaloid; veratric acid, and sabadilline, a heart stimulant.

Neither the consular report nor the Smithsonian pamphlet gives the formula for the manufacture of the war gases, but it is stated in the former that the dust from the seed in the field irritated the eyes, throat, and especially the nose, so much that the native laborers were obliged to wear masks. It has been reported that the Germans had bought all the available supply of these seeds before the declaration of war. Both the sabadilla seeds and all preparations compounded from them are now, however, declared contraband by England.

Another plant of the same genus grows wild in Texas, and some botanists believe that should a need for sabadilla arise here it could easily be cultivated in Texas and in other southern states. Dr. Rose collected many other specimens during his trip, primarily in the mountains about Caracas and Puerto Cabello, where he made an especial search for cacti and orchids.

Mr. Paul C. Standley, another botanist of the National Museum, spent three weeks in the vicinity of Fort Myers, on the west coast of southern Florida, collecting plants and studying the local flora. He was later detailed for field-work in New Mexico, and remained for four weeks at Ute Park, where he gathered over 5,000 specimens, including several genera new to the state, and many additional species. During his work, he secured the largest collection of cryptogams, the flowerless plants propagated by spores or simple cell division, ever obtained in New Mexico. This collection includes about 300 species of fungi not previously found in this state.

The Smithsonian pamphlet also describes the botanical explorations of Professor A. S. Hitchcock in the Hawaiian Islands, a report of which will be published shortly.

WAR SERVICE FOR CHEMISTS[1]

Chemists and chemical engineers are normally needed in almost all branches of industry (including the standardization and control of food products) for the successful operation of processes, the detection and speedy correction of difficulties and the improvement of products. England, France and Italy found it necessary to recall all chemists from the ranks; Canada does not allow chemists to enlist; chemists have saved Germany up to the present time.

There was a decided shortage in the supply of chemists in the United States even before April, 1914. The war has made the shortage acute, and it is certain that our own war needs and industries necessary to war will absorb chemists as rapidly as they can be trained.

It takes from four to seven years to *train* a chemist. The shorter time is for college graduates and chemical engineers who become wholly useful only after a further year of experience in a manufacturing plant or laboratory (corresponding to the hospital year required of medical students). The longer time is for the training of research men taking the doctorate degree in chemistry, on whose shoulders ultimately the vast need of the government and the industries fall for meeting and solving new difficulties and problems of organized research.

When chemists of mature years are called in for service in government laboratories, their places must be filled by younger men to keep the machinery working. It is, therefore, of the greatest importance that steps be taken:

1. To keep and impress into service *in chemical* lines chemists drawn by the draft for service in the United States Army or Navy.

2. To provide means for keeping open sources of supply of chemists from universities, colleges, and schools of technology, and to procure volunteers in chemistry.

A tentative plan for accomplishing these results is hereby appended and recommended.

William H. Nichols, *chairman of the Chemistry Committee, National Defense Council.* Past-president, Society of Chemical Industry. President, Eighth International Congress of Applied Chemistry.

Marston T. Bogert, *chairman of the Chemistry Committee, National Research Council.* Past-president, American Chemical Society.

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[1] Report to the Council of National Defense.

A. A. Noyes, *Past-president, American Chemical Society.*

Julius Stieglitz, *President, American Chemical Society.*

Charles L. Parsons, *Secretary, American Chemical Society.*

PLAN FOR THE IMPRESSMENT OF CHEMISTS FOR WAR SERVICE AS CHEMISTS AND FOR THE PRESERVATION OF THE SUPPLY OF CHEMISTS

I. There shall be organized a committee of three to advise the President of the United States through the War Department on requests for exemption of chemists. This committee might well include besides a government representative two chemists, one a chemical engineer or technical chemist, the second a university man. These men should be nominated to the President by the Council of National Defense.

II. Requests for exemption of individual chemists shall be made to this committee by:

1. Government, state or municipal laboratories and bureaus.

2. Heads of manufacturing plants on the basis of the imperative need of these men for their successful operation.

3. Presidents of universities, colleges and schools of engineering or mining on the basis of proficiency, promise and ability of candidates for college or university degrees, specializing in chemistry. Men recommended under this head who are candidates for the doctorate degree shall not be over 26 years of age when they receive the degree, and men who are candidates for a four-year college degree shall not be over 23 years of age when they are to receive the degree.

III. (1) Chemists under 21 and over 30 years of age and chemists between 21 and 30 who have not been drafted may enroll with the above committee as volunteers in chemistry subject to the same conditions as the enlisted and exempted men.

(2) Students in chemistry under 21 years of age may enroll with the above committee for a "chemists reserve" under the conditions specified in II. (3).

IV. Men thus enrolled and accepted under the provisions of the above paragraphs for war service as chemists shall be subject to the orders of the government as to location and nature of service and shall be entitled to wear a badge or other insignia indicating their official status (practise of France and possibly of other European countries). Students enrolled in a "chemists reserve" shall be subject to the same conditions as obtain for other reserves of the government and shall also be entitled to wear some insignia or badge indicating their enrollment.

SCIENTIFIC NOTES AND NEWS

A commission under the chairmanship of Dr. Frank Billings, of Chicago, is about to leave for Russia, under the auspices of the war council of the American National Red Cross. Its members include specialists in sanitary science, general medicine, tuberculosis, bacteriology and other branches of medicine, engineering, foods, transportation, business, etc. Mr. William B. Thompson, of New York, is assuming the expense of the commission.

Forty-five engineers of the topographic branch of the Geological Survey who are members of the Engineer Officers' Reserve Corps, have been assigned to active duty in connection with the military mapping now being done for the War Department. Among the men affected are Majors Frank Sutton, William H. Herron, Robert B. Marshall, Glenn S. Smith, George T. Hawkins, Robert Muldrow, James H. Jennings, William H. Griffin, Robert H. Chapman, Joseph H. Wheat and Albert M. Walker; Captains Claude H. Birdseye, Emory I. Ireland, Clyde B. Kendall, Albert Pike, Herbert H. Hodgeson, Carl L. Sadler, J. G. Staack, William L. Miller, Eugene L. McNair, Asahel B. Searle, William O. Tufts, Bertram A. Jenkins, James W. Bagley and Calvin E. Giffin. The list also includes twenty first and second lieutenants.

Mr. Henry S. Graves, chief of the U. S. Forest Service, has arrived in Paris to make arrangements for the forest work which the American army engineers will undertake in France in connection with the military operations of the allied forces.

Dr. Allerton S. Cushman, president of the Institute of Industrial Research, with headquarters at Washington, D. C., has been commissioned a major in the Officers' Reserve Corps, and will carry on special research work under the ordnance section on the chemistry of high explosives.

Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research, who has been at the head of one of the French military hospitals, arrived in the United States on July 4.

Mr. C. P. Winslow has been appointed director of the Forest Products Laboratory to succeed Mr. H. F. Weiss, now in charge of the Division of Forest Products of the C. F. Burgess Laboratories. Dr. S. F. Acree severed his connection as chief chemist at the laboratory and is now with the National Wood Chemical Association, with headquarters at Syracuse University.

Dr. Frank D. Adams, of the faculty of applied science of McGill University, has been elected a foreign honorary member of the American Academy of Arts and Sciences, Boston, Mass., and also an honorary member of the Mineralogical Society of Russia at Petrograd.

Mr. J. J. Manley, the curator of the Daubeny Laboratory, has been elected to a fellowship at Magdalen College, Oxford, for the prosecution of special researches in physics and chemistry.

The committee on science and the arts of the Franklin Institute has awarded its Edward Longstreth medals of merit to Professor A. E. Kennelly, Messrs. F. H. Achard and A. S Dana, for their joint paper entitled "Experimental researches on the skin effect in steel rails," appearing in the August, 1916, issue of the *Journal* of the Franklin Institute.

Mr. John Hall Sage, secretary of the American Ornithologists' Union was, on April 20, the guest of Dr. A. K. Fisher, at the camp of the Washington Biologists' Field Club, at Plummer's Island in the Potomac near Washington, D. C., where they were joined by sixteen other fellows and members of the union who gathered there in honor of Mr. Sage's seventieth birthday.

A complimentary dinner was recently given to Mr. Thomas J. Parker by some of his friends, at the Chemists' Club, New York City. The speakers were Dr. Milton C. Whitaker, Professor Chas. F. Chandler, Dr. Charles H. Herty and Dr. Hugo Schweitzer.

Dr. Robert H. Lowie, associate curator of anthropology at the American Museum of Natural History, has received a temporary appointment as associate professor in the University of California for the academic year 1917–18. He has been given a leave of absence by the American Museum of Natural History. In exchange, Professor A. L. Kroeber will join the staff of the museum during the first half of the year 1918.

Professor H. H. Bartlett has received leave of absence from the University of Michigan for the next year and a half in order that he may take charge of the laboratories of the United States Rubber Co. in Sumatra. At a recent meeting of the board of regents of the university, a letter was presented from Professor Bartlett with respect to a clause in the contract between himself and the United States Rubber Company relating to certain fellowships to be established in the university during Professor Bartlett's absence by the company in order to retain certain of Professor Bartlett's graduate students. This clause received the approval of the board.

Professor R. G. Hoskins, of the Northwestern University Medical School, has been appointed editor of *Endrocrinology*, the bulletin of the Association for the Study of the Internal Secretions.

Mr. George H. Ashley has returned to the U. S. Geological Survey, Washington, D. C., having concluded his term as acting professor of geology in Vanderbilt University. He took the chair of geology for six months in the absence of Professor L. C. Glenn.

W. E. Tottingham, assistant professor of agricultural chemistry, College of Agriculture, Madison, Wis., is on leave of absence and is working at Johns Hopkins University with Professor Livingston, on special problems in plant chemistry and physiology.

Julius Otto Schlotterbeck, professor of pharmacognosy and botany and dean of the College of Pharmacy of the University of Michigan, died on June 1.

The death occurred at Cambridge on June 9 of T. McKenny Hughes, F.R.S., Woodwardian professor of geology in the university, at the age of eighty-five years. He was elected a fellow of the Royal Society in 1889, and received the Lyell medal of the Geological Society in 1891, when he acknowledged the value of his intimate association with Sir Charles Lyell, with whom he made many geological tours during his early years. As Sedgwick was elected Woodwardian professor in 1818 he and his successor have between them occupied the chair for ninety-nine years.

HORAS T. KENNEDY, geologist of the Geological Survey of Ireland, was killed on June 6 while serving as lieutenant in the British Army.

THE annual meeting of the American Chemical Society will be held in Boston on September 11, 12 and 13. We learn from the *Journal of Industrial and Engineering Chemistry* that the Northeastern Section has been requested by the directors to omit the usual annual banquet and excursions, and to arrange a program characterized by simplicity and seriousness, and bearing as fully as possible on questions concerning the activities of chemists both in the government service and in the industries during the present war. The general meeting will be held on Tuesday morning. This will be followed in the afternoon by a general conference to be opened by Dr. W. H. Nichols, chairman of the committee on chemicals of the National Defense Council, and by Dr. M. T. Bogert, chairman of the Chemistry Committee of the National Research Council, the conference then to be continued from the floor. It is expected that an informal, get-together meeting of a social character will be held on Tuesday evening, at which time opportunity will be given for informal discussion of problems of the day. Wednesday morning will be devoted to divisional conferences, and the afternoon to divisional meetings, with papers, or a continuation of the conferences, as the divisions may decide. The presidential address will be delivered on Wednesday evening. Thursday, both morning and afternoon, will be given to divisional meetings.

THE Rockefeller Foundation has awarded contracts for the building of two hospitals to cost $3,000,000. One of these will be located in Pekin and the other in Shanghai, and both will be for the work of the China Medical Board. It is also announced that the Foundation will send a hospital ship to the Moros and allied tribes of the Sulu Archipelago. The Philippine government is cooperating in this enterprise. The ship will cruise for five years among the many islands in the southern Philippine group. The foundation has learned that many of the Moros are suffering from skin diseases, malaria, hookworm, dysentery and other diseases.

THE state health commissioner of Massachusetts has appointed as a committee on the conservation of child life, Drs. David L. Edsall and William J. Gallivan, members of the public health council, and Dr. Lyman A. Jones, director of the division of hygiene of the state health department. As consulting members he has named Drs. Fritz B. Talbot, pediatrist and chief of the children's medical department, Massachusetts General Hospital; Richard M. Smith, Boston, pediatrist, assistant in pediatrics, Harvard Medical School; Walter E. Fernald, psychiatrist, superintendent of the Massachusetts School for the Feebleminded, and William Healy, psychologist, director of the psychopathic institute of the Chicago Juvenile Court, and Miss Mary Beard, director of the Instructive District Nursing Association.

THE *Journal* of the American Medical Association states that on June 20, a session was held at the College of Physicians and Surgeons, Philadelphia, at which physicians past the age for medical service organized for the reclamation of men physically unfit for the United States Army or Navy. Dr. W. W. Keen was elected president of the organization and as vice-presidents, Drs. John B. Deaver and James M. Anders. Physicians more than 55 years of age, doctors who can not pass the reserve corps medical examination and physicians who for other reasons can not go to the front, will form the membership of the organization which will include also dental surgeons, pharmacists and chiropodists. The plan is to have a camp where men who have been refused service in the army or navy for minor defects may have these defects cured or so remedied that they will be able to enlist later. This is carrying out the plan of Dr. William Duffield Robinson, which won the approval of the surgeon-general. The entire equipment of the Germantown Hospital has been offered.

UNIVERSITY AND EDUCATIONAL NEWS

The will of the late Colonel Oliver H. Payne provides bequests of more than $7,000,000 to charitable and educational institutions. The largest gifts are to Yale University, Lakeside Hospital, Cleveland, and the New York Public Library, each of which will receive $1,000,000. An endowment of $500,000 is bequeathed to the Cornell University Medical College. Other gifts include: Phillips Academy, Andover, Mass., $500,000; St. Vincent's Charity Hospital, Cleveland, $200,000; Cleveland Jewish Orphans Asylum, $200,000; Hamilton College, Clinton, N. Y., $200,000, and the University of Virginia, $200,000.

Mrs. Reed, widow of late Dean John O. Reed, has presented to the library of the department of physics of the University of Michigan about 400 scientific books and bound reprints from the library of Professor Reed, the books being principally on physics and mathematics. There was received from Mrs. Reed, also, a gift of eight prisms of special design of various kinds of glass and natural crystals made by Professor Reed and used by him in research work. Mrs. Guthe, widow of the late Dean Karl E. Guthe, has presented to the library about 100 volumes of scientific works from Professor Guthe's library, together with about 1,000 catalogued reprints of scientific papers and a card catalogue of several thousand references.

Professor Robert DeC. Ward, of Harvard University, is giving instruction in meteorology in the school for the preliminary training of aviators, recently established at the Massachusetts Institute of Technology, in cooperation with the War Department. For the purposes of this work, Professor Ward has become a member of the teaching staff at the Institute of Technology, and, under orders from the War Department, has been to Toronto to familiarize himself with the instruction which is there being given at the Cadet School of the Royal Flying Corps.

The State College of Forestry at Syracuse announces the appointment of Mr. Ernest G. Dudley, of Leland Stanford University and the Yale Forest School, as assistant professor of forest extension. Mr. Dudley goes to the college from the U. S. Forest Service in California where he has recently been in charge of the Forest Service Exhibit at the Panama-California Exposition in San Diego.

Dr. Milton C. Winternitz, formerly associate professor of pathology in Johns Hopkins University, has been elected professor of pathology in the school of medicine of Yale University.

DISCUSSION AND CORRESPONDENCE

A REMARKABLE COINCIDENCE

The most remarkable coincidence known to me relates to the discovery of Perrine's second comet. I published the facts in the case in *The Observatory*, Vol. 26, pp. 293–94, 1903, where they were made familiar to many astronomers. On describing the coincidence recently to a group of my colleagues in other sciences they urged strongly that I republish the facts in a journal of more general character, and thus make known the occurrence to students in other subjects.

Professor Charles D. Perrine, of the Lick Observatory staff, discovered the first of his many comets on November 17, 1895. This was Comet *c* 1895. He observed it night after night until December 20, 1895, when it was lost to sight in the glare of the sun's rays. The orbit of the comet was accurately determined, and its path for the early months of 1896 was computed and published in advance. I had the pleasure of assisting Mr. Perrine when he first looked for its reappearance from behind the sun, on the morning (just before dawn) of January 30, 1896. He found it at once, in the predicted position, and as an object easily visible in medium-sized telescopes. Because the comet was following its predicted path so closely we decided not to squander money in cabling the fact of its reobservation to European observers. Perrine observed his comet morning after morning as weather permitted, for fifteen days, until on February 14 a cablegram was received from Kiel, Germany, announcing that Lamp had reobserved Perrine's Comet *c* 1895 that morning. The cablegram in cipher code was received at the Lick Observatory by one of the astronomers, in perfect order as shown by the control word; but in converting the cabled right ascension of the comet from degrees and minutes of arc into hours and minutes of time the translator made an error of 24 minutes of time, equivalent to 6° of arc. The *erroneous* translation was handed to Perrine. He compared this with what he knew to be the real position of Comet *c* 1895, by virtue of his observations in the preceding half month, and saw that there was a discrepancy of about 24 minutes of time. Inasmuch as the check word in the cablegram was correct he judged that the object observed by Lamp in Kiel must be a different comet from his own. The following morning was clear and he pointed the 12-inch telescope to the position that was handed to him. In looking through the finder of the telescope *he saw an eighth magnitude comet in the field of view.* This did not surprise him. He observed the position of the new comet, and we transmitted the observation by telegraph and cable, as usual, as belonging to a new comet discovered by Lamp in Kiel. This new object was at once known as Comet *a* 1896. Naturally considerable mystery existed (see *Astronomical Journal,* Vol. 16, p. 56, 1896, and *Astronomische Nachrichten,* Vol. 139, pp. 365–66, 1896). Several weeks elapsed before the tangled situation was unravelled at Mount Hamilton by our looking up the original cipher cablegram and detecting the error of 24 minutes in the conversion of arc into time, made after the cipher message had been translated and checked.

It is a surprising fact that the error should have directed the telescope upon an unknown comet, but the surprise increases when we consider another attendant fact. The new comet was moving amongst the stars very rapidly; more than 2° east in right ascension and more than 3° north in declination, daily. When the cablegram was written in Kiel on the morning of the fourteenth the new comet was six or seven degrees from the cabled position. When the erroneous position was handed to Perrine on the morning of the fourteenth the new comet was three degrees from that position. When the first opportunity came, the following morning, to examine the erroneous position, the rapidly-traveling comet had moved into that position. Had the telescope been pointed to that position on any other morning whatsoever, the celestial visitor would have been far outside the finder field, and the chances are fair that it would have come and gone unseen. The cabled Kiel position of reobservation of Comet *c* 1895 and Perrine's position of Comet *a* 1896 were:

Comet *c* 1895, Feb. 14, R. A. = 19 h. 45 m.,
Dec. = − 2° 23′ (correct translation).
Comet *c* 1895, Feb. 14, R. A. = 19 h. 21 m.,
Dec. = − 2° 23′ (erroneous translation).
Comet *a* 1896, Feb. 15, R. A. = 19 h. 22 m.,
Dec. = − 2° 49′.

The angular radius of the finder field was about 1° .3.

I doubt whether another case of coincidence as remarkable as this one is on record in the literature of astronomy.

W. W. Campbell

Lick Observatory,
June 4, 1917

REPORT OF DR. E. H WILLIAMS ON THE FIRST PHASE OF PENNSYLVANIA GLACIATION

When in 1880 Professor Lewis and myself conducted the survey of the terminal moraine across Pennsylvania (the results of which are embodied in volume Z of the Second Geological Survey of the State) we supposed at the outset that we were following the actual limit of glaciation. Soon, however, we were convinced of our error and spoke of a "fringe" of territory sparsely covered with glacial markings, extending an indefinite distance beyond. In deference to others we had no objection to substituting the words "attenuated border" for the word we had selected. The only person who has studied this "attenuated border" comprehensibly and in detail, in Pennsylvania, is Dr. E. H. Williams, Jr., whose attention was called to the problem twenty-five years ago, while he was lecturer on mining and geology, at Bethlehem.

By good fortune Bethlehem is almost exactly on the exterior limit of this attenuated border; and Dr. Williams' familiarity with the mineralogy of the region and with the many problems connected with the work of mining engineering, specially fitted him for prosecuting the investigations which he began and pursued at his own expense until the work was completed. Though many of the results of this work had been presented in piecemeal in various publications, it is only now that they are published in complete form and with adequate description and illustrations, of which there are no less than fifty-six, mostly photographic reproductions.

Following the example of Professor Chamberlin, who first gave a satisfactory explanation of the lobate character of the moraines west of Pennsylvania, in the topography of the region, Dr. Williams has brought to light as never before the causes operating to direct and limit the movements of the ice over the mountainous regions of New England and the Middle States.

1. There was a lobe extending southward between the Green Mountains and the Adirondacks through the Hudson Valley, the rock floor of which, between Lake Champlain and the Hudson River, was only 150 feet above tide. The average breadth of the upper Hudson Valley between the 500-foot contour is sixteen miles. Between the 1,000-foot contours it is thirty-two miles; but at South Kingston, New York, Storm-King and Marlborough Mountains rise abruptly 1,200 feet above the valley with a gorge between them, through which the river flows, only three fifths of a mile broad at the 500-foot contour and two miles at 1,000 feet. As a consequence the ice stream was diverted to the southwest through the Walkill-Rondout saddle into the great Pennsylvania valley, extending as far as Bethlehem, and damming up the Lehigh Valley so that the outflow of the drainage was turned over the watershed between the Lehigh and the Schuylkill at Topton; thus accounting for the glacial drift, which had been recognized by Salisbury, in the Schuylkill River at Norristown.

A natural explanation of the northwest trend of the glacial border, as shown in eastern and middle Pennsylvania, is found in the gradual rise of land to the west, which in Potter County attains an elevation of 2,500 feet. But in Schuylkill County the swelling mass of ice surrounding and finally overtopping the Catskill Mountains penetrated to Morea a few miles north of Pottsville leaving glacial markings of great interest on the surface of the mammoth coal bed, at an elevation of 2,100 feet above tide.

Again, as the Labrador ice advanced and increased in volume, passing around the elevation of the Adirondack Mountains it penetrated the Mohawk Valley through the Black River sag and entered the east fork of the Susquehanna, reaching the valley of the West branch at Williamsport and crossing over it so as to produce a dam causing the water to extend up Eagle Valley and run over into the Juniata at Tyrone, thus accounting for the glacial débris that I. C. White had found in the lower Juniata.

But it is in northwestern Pennsylvania that most interesting facts come to light. It appears that there was a long interval after the Kewatin and the Labrador glaciers set out upon their careers before they became confluent; so that when the Kewatin ice invaded the valley of the Great Lakes and poured its torrential drainage into that valley, Labrador ice was obstructing the eastward exits both through the St. Lawrence and through the Mohawk. This caused a rise of water over the basin of western Ontario and western New York, until, through the Conewango, it eventually found an exit into the Allegheny Valley, which then was not continuous but was separated by a col somewhat south of Franklin from which streams were flowing both north and south. But this col was rapidly reduced by the glacial torrents and thus the present channel was formed. It was during this period that those remarkable deposits in the Conewango and the Allegheny about Warren were formed. At the bottom there is an immense deposit of fine sediment in horizontal laminæ giving place towards the surface, which rises 300 feet or more from the rock bottom, to coarser deposits indicating a southward flow of water.

One of the most interesting discoveries at this point is a nugget of Lake Superior Copper embedded in undisturbed deposits of glacial origin, dropped as Dr. Williams believes by icebergs floating in this temporary lake. Nuggets of copper which Dr. Williams is pretty confident are from the Lake Superior region are also found in glacial deposits of eastern Pennsylvania, brought thither as he believes by icebergs, which in an earlier period passed through the Mohawk Valley before it was completely obstructed by the Champlain-Hudson lobe of ice.

Dr. Williams names his brochure "Pennsylvania Glaciation; First Phase," and gives ample reasons for believing that in the East, at any rate, there is not that immense separation between the earliest and latest phases which geologists in the Mississippi Valley have been accustomed to assume as separating the Kansan from the Wisconsin stages. In Pennsylvania it is certain that such a wide separation can not be maintained; for, though it is true that the glacial deposits over the attenuated border are in general more highly oxidized than those in and north of the moraine, *they are not all highly oxidized.* Mingled with the highly oxidized material of this area there is a small proportion of comparatively fresh material, and it is that which must determine the age. It is evident that the most of the material on the attenuated border was oxidized in preglacial times and was brought forward in that condition by the ice movement. For example, numerous pebbles are found which are oxidized on the outside, while there is a core on the inside that is unoxidized, while in some instances such pebbles have been ground off on one side by the glacial movement, exposing this unoxidized core and leaving the thick covering of oxidization on the other side.

Certainly the scientific public is greatly indebted to Dr. Williams for the pains which he has taken: first, to collect the facts which are found in this brochure, and second for bringing them before the public in such full measure, at his own expense. No glacialist can afford to remain ignorant of the facts and discussion of principles contained in it. The reader will lack only a detailed map of the state of Pennsylvania, which he needs to have constantly before him. The small relief map accompanying the publication is good so far as it goes, but needs to be supplemented for reference by one that gives minute details of topography and geology.

G. FREDERICK WRIGHT

OBERLIN,
May 22, 1917

QUOTATIONS

THE WAR AND SCIENTIFIC INVESTIGATION

THE commendable patriotic ambition of every rightminded American to render his best help in the time of his country's need has raised questions of choice for many citizens. The spirit of service is rife throughout the country, and one's first impulse frequently urges him to enter those avenues of activity that lead nearest to the combat. A sane, calm review of the situation indicates, however, that there are many fields which require profound attention, even though they often seem quite remote from the trenches. The chemist in the munitions works, the bacteriologist who is testing the efficiency of the latest antiseptics, the agriculturist who is striving to solve the immediate difficulties of farm practise or aiding in the "speeding up" of the production of staple crops, live stock and other food products—all of these workers are an indispensable part of the great human organization that must cooperate to lead the way to victory. Frequently many workers, particularly younger men engaged in important investigations, gain the uncomfortable feeling that they are not doing their full duty when they plod along so far removed from the noise of the conflict. Such persons need encouragement at the present moment. They must not all be permitted to withdraw from the less conspicuous though highly important labor of productive investigation which may anticipate the needs of the hour. The war has already directed attention as never before to the intimate relations between science and industry, as well as to the vital necessity of fostering these relationships. Two generations ago, Dr. Lyon Playfair deplored the holding "to mere experience as the sheet anchor of the country, forgetful that the molds in which it was cast are of antique shape, and ignorant that new currents have swept away the sand which formerly held it fast, so that we are in imminent risk of being drifted ashore." Despite the brief period full of the enormous difficulties of organizing a great military campaign and instituting active defenses as well as naval warfare, substantial headway has already been made in the mobilization of scientific investigation. Researches can not be manufactured on command or completed over night. Nevertheless the National Research Council has already made a commendable beginning in a movement that will enlist some of the best scientific minds of the nation and encourage them to continue the work for which they are specially trained and best equipped. In our enthusiasm for the more apparent helps to success we must not forget these potent silent forces, nor allow the leaders of the nation to overlook the need of supporting and stimulating them. Even war thrives thrugh the fundamental discoveries of science. —The *Journal* of the American Medical Association.

SCIENTIFIC BOOKS

Tomorrow: Letters to a Friend in Germany. By HUGO MÜNSTERBERG. D. Appleton & Co. $1.

As soon as Columbia really sets her face toward peace, the war clouds will be dispelled and the age of our hopes will dawn. My mind is gleaming with radiant hopes. Peace must come soon, and who knows, my friend, when the roses bloom again in your beautiful garden, one of the German ships interned here in Boston may have brought me back to the Fatherland to you. I am sure in one wondrous hour at home I can tell you face to face so much more than I have told you in these letters. Yes, when the roses bloom. . . .

The roses will bloom, and perchance peace will come, but the author of these hopeful words has departed, leaving a message which will not soon be forgotten. Professor Münsterberg wrote his last book, well called "Tomorrow," in the form of letters to a friend in Germany. The professor of psychology has given us a study of extraordinary psychological interest; wherein, under a certain appearance of unity, we see the ferment of German and American ideals, and their influence on a scholarly mind. When he came to this country, Münsterberg stipulated that he would remain a German citizen. He did so remain, in a political sense; yet he could not escape Americanization, and his last wish, in the midst of war and of anti-Germanism, is for the union of Germany, England and the United States!

Nevertheless, the German point of view is never forgotten. The ideal is nationalism, combined with a not too insistent internationalism. Science, philosophy, art, must be international; the new nationalism of Germany, which "pleads for a kind of intellectual embargo," is petty and dangerous to real culture; yet "truth must be clothed in its national garb." What is nationalism? It is not the cult of race: "we have heard so often and with so much assurance the story of the omnipotence of race in human history. The true psychologist always knew that it was a legend, and the war has demonstrated it again." Yet, we are told, "in every nation we grasp a oneness of traditions and memories, of language and customs, of laws and literature, of arts and sciences, of commerce and politics, of morals and religion." Do we, indeed? In Switzerland or the British Empire, for example? Is it not a fact that the nation, as nations go today, is an artificial alliance for economic purposes? The real groupings of mankind, in a spiritual, intellectual or even historical sense, are usually not coincident with national boundaries, and afford no support to the doctrine that nations are the most sacred of all human units. How far Münsterberg could be led astray by the ideal of nationalism is shown in his defense of the militant professors who, "uplifted by a healthy patriotism," proclaimed historic and political facts as they appeared from the angle of their hopes (p. 37); yet he hastened to add that "while our beliefs may clash, no hatred ought to darken our vision."

The new idealism, as interpreted by Münsterberg, is that of organization for public service. "Where individualism prevails, subordination is unwelcome; and that means that dilettantism flourishes and the expert is powerless. The dilettant is now ruled out and the triumph of the expert secured all over the world for the days to come; organization replaces haphazard performance; the self-conscious will of the group suppresses the individual whim. To have attained this is the most important victory of the German nation. If the war brought nothing else, this alone may make us feel that those who died on both sides did not give their lives in vain" (p. 137). With this interpretation, the new nationalism finds fresh meanings. The nation is now the cooperative unit. It is the machine, all parts of which work together in harmony. Why not extend this idea further, and let the unit be mankind?

The conception of universal cooperation, once we have grasped and appreciated the extraordinary coherence of such a strange conglomeration as the British Empire, is simple and attractive. Since nations, artificial as they are, are such workable units in time of stress, what is to prevent the extension of the national method until nations are no more? Münsterberg looked forward to something like that: "the world federation ought to be an ideal . . . but it must have ages to mature." It can not come through law, but must arise "out of the needs of the active nations," must be dynamic and constructive.

The interplay of diverse ideas and ideals produces inconsistencies which alternately irritate and charm. It is irritating to find what seems to be a failure in the integrity of scientific reasoning, but one is charmed at the naïve sincerity of the utterances. After all, the road to salvation is not the straight and narrow path we have been led to imagine, but has many turns. Every promising path appears to have its obstacles and its dangers. Even the federation of the world might lead to an ossification of the springs of originality in mankind. State socialism may go the way of all organization carried to extremes, and lead to petrefaction.

History shows us that the causes of progress are largely individual. The new movement arises as a consequence of the breaking away of some personality from the fetters of the established order. He may be crucified, but his work permeates society, and fructifies through social cooperation. Thus individualistic and socialistic forces are alike indispensable for progress. Münsterberg seems not to have fully appreciated this; the Germans, as a nation, do not appreciate it, and that is why we dread the "Prussianization" of the world. On the other hand, we have not sufficiently appreciated the importance of organization; and here in America, in particular, the work of individuals fails for lack of adequate cooperation.

We grant with Münsterberg that a genuine idealism is at the base even of German warfare. He himself defines it exactly. "It is a belief in 'absolute' values. . . . Belief in absolute values means simply that the deed is valued independent from the pleasure it brings. . . . If we are filled with the belief that an action has value without any reference to pleasure or pain, then we credit it with absolute value. To be guided in life by such a belief is idealism." This conception is expanded quite fully, and as presented has its attractive side. Indeed, who can go through life sanely or usefully without some such idealism, some belief in unprovable axioms or "absolute values"? Yet modern science becomes more and more experimental, more and more inclined to test all things, and hold fast to that which is good, *as shown by the test.* Pragmatism may be vicious when narrowly conceived, but the pragmatic attitude leads us away from dogmatic idealism toward intelligent action. The German army, in its conduct toward its own members as well as its treatment of the unfortunate peoples who come under its power, does indeed strive for "values" independently of pleasure or pain. Nationalistic idealism can be made the excuse for deeds which could find no justification in the presence of the simplest enquiries into consequences, as measured by those supposedly negligible phenomena, human pleasure and pain. Münsterberg, great-hearted and striving after good, would not have so far forgotten the relations between cause and effect; but we must combat any philosophy, any course of action, which does not incessantly seek justification by results measured in human welfare.

T. D. A. Cockerell

SPECIAL ARTICLES

A RHYTHMICAL "HEAT PERIOD" IN THE GUINEA-PIG

During the past six years we have been using guinea-pigs in an extensive breeding experiment and it has become more and more evident as our work goes on that the existing notions of the ovulation periods in these animals are of no practical value, or are practically incorrect. In a number of the experiments it became important to know accurately when the females "came into heat" and when ovulation took place. We had concluded, from numerous observations as well as theoretically, that the female guinea-pig very probably had a definitely regular and periodic sexual cycle if it could be worked out exactly. On account of the need of this exact information, we have studied the œstrous cycle in these animals during the past eighteen months.

Most other attempts at a solution of this problem have centered in a study of the ovary, which necessitated either its removal by operation or the killing of the animal. In either case the procedure brought to a conclusion the observation or experiments on the ovulation cycles in that specimen. Recognizing, on the other hand, that no thorough investigation of the uterus and vagina in the living female had been made, it occurred to us that possibly œstrous changes might take place even though they are so feebly expressed as not to be noticeable on casual observation. The absence of an apparent œstrous or proœstrous flow from the vagina of the guinea-pig has, no doubt, been the chief reason for the general lack of knowledge of the œstrous cycle. It was, therefore, determined to make a minute examination of the contents of the vaginæ of a number of females every day for a long period of time to ascertain whether a feeble flow might exist, although insufficient in quantity to be noticed at the vaginal orifice or vulva.

The observations were made by using a small nasal speculum which was introduced into the vagina and the arms opened apart by means of the thumb screw. This instrument permits an examination of the entire surface of the vaginal canal. In this way the vaginæ of a number of virgin females have been examined daily and smears made from the substances that happened to be present in the lumen.

By the use of such a simple method, it was readily determined after examining the first lot of animals for a few months that a definite sexual period occurs lasting for about twenty-four hours and returning with a striking regularity every fifteen or sixteen days. During this twenty-four hour period the vagina contains an abundant fluid which is for about the first half of the time of a mucous consistency. The vaginal fluid then changes into a thick and cheese-like substance which finally becomes slowly liquefied and serous. This thin fluid exists for a few hours and then disappears. Occasionally toward the end of the process a slight trace of blood may be present, giving the fluid a bloody red appearance, otherwise it is milk-white or cream color.

According to the changes in appearance and consistency of the vaginal fluid, one may distinguish four different stages. The first stage having a mucous secretion, a second stage the cheese-like secretion, a third stage with the fluid becoming serous and a fourth stage, not always recognized, during which a bloody discharge is present. The duration of these several stages is subject in the different animals to individual variations. The first stage, however, is generally longest and lasts from six to twelve hours or even more, and during this time there is a gradually increasing quantity of the mucous secretion which at its height is very abundant and fills the entire lumen of the vagina. The second stage is shorter, lasting from two to four hours, and passes gradually over into the third stage which lasts from four to six hours. The fourth stage is the shortest, only about one to two hours long, and for this reason it is often missed in examining the animals during the periods. It is also possible, as mentioned above, that the fourth stage may not typically exist in all individuals and the quantity of blood present is very different in the different specimens. The succession in which these stages follow one another is remarkably definite. We have never observed any change in the typical sequence of the stages and the time consumed by the entire process is closely the same in all cases.

A macroscopical examination of the uterus and vagina during this period of sexual activity shows the entire genital tract to be congested. The vessels to the ovary, uterus and vagina are large and conspicuous, the uterine horns and the vagina are slightly swollen and inflamed. However, as soon as this short period of activity is over, the congestion disappears and the uterus and vagina take again their normal pale aspect. At the same time the vaginal fluid diminishes and the vagina, especially during the first week after the sexual activity, is as clean as possible, showing none of the secretion. The external vaginal orifice, which during the period of activity is more or less open, actually showing in a few cases a little fluid or some blood, closes and becomes less accessible after the period.

During the second week following œstrus a little mucous discharge begins to appear in the vagina and increases progressively, indicating that the new period of activity is nearer and nearer approaching. The orifice of the vagina is sometimes open during this stage and thus explains why this sign, which was observed before, does not make it possible to detect the actual time of the regular œstrous activity.

The complete results of the present study which will be published in full elsewhere may be stated in brief as follows.

Guinea-pigs kept in a state of domestication and under uniform environmental conditions possess a regular diœstrous cycle repeating itself in non-pregnant females about every sixteen days throughout the entire year with probably small and insignificant variations during the different seasons.

During each cycle typically corresponding changes are occurring in the vagina, the uterus, and the ovary; a given stage in one of these organs closely accompanying parallel stages in the other two.

Each period of sexual activity lasts about twenty-four hours and is characterized by the presence of a definite vaginal fluid, which is not sufficiently abundant to be readily detected on the vulva, but is easily observed by an examination of the interior of the vagina.

The composition of the vaginal fluid changes with the several stages of change occurring in the uterus and vagina.

(*a*) To begin with, during what we term the *first stage*, the fluid consists of an abundant mucous secretion containing great numbers of desquamated vaginal epithelial cells. At this time sections of the vagina show an active shedding or desquamation of its epithelial lining cells. The cells of the uterine epithelium are loaded with mucus, and an active migration of polynuclear leucocytes is taking place from the vessels of the vagina and uterus out into the stroma and towards the epithelial layer.

(*b*) During the *second stage* the contents of the vagina become thick and cheese-like on account of the great accumulation of desquamated epithelial cells. The walls of the uterus and vagina become congested and the migration of leucocytes becomes still more active.

(*c*) The leucocytes reach the epithelium and vigorously invade its cells and intercellular spaces during the *third stage*. These wandering cells become enclosed within and apparently dissolve the breaking-down dead cells of the epithelium. The vaginal fluid becomes thinner under the dissolving or digesting action of the leucocytes. The congestion in the uterus and vagina becomes still more pronounced, giving rise to small blood masses or hæmatomata beneath the epithelium. The epithelium of the uterus is highly disorganized, vacuolized and richly invaded by the leucocytes, so that portions of it fall away en masse, actually carrying with it in some cases cells of the stroma.

(*d*) The *fourth stage* is merely a continuation or result of the activities of the third. The falling away of the epithelial pieces and stroma cells permits the escape of the small hæmatomata or blood knots, thus causing a slight bleeding into the lumen of the uterus and vagina. These traces of blood often give a reddish aspect to the vaginal fluid. At this same stage a regeneration process begins from the necks of the uterine glands and also apparently from the epithelial infoldings in the vagina, so that the lost epithelium becomes rapidly replaced almost before it has ceased falling away.

The regeneration process in the guinea-pig is very short, lasting only a few hours, from six to twelve in all.

Ovulation seems to occur spontaneously during every heat period without exception. The rupture of the follicles with the consequent ovulation takes place about the end of the second stage or the beginning of the third; that is, during the presence of the thick cheese-like vaginal fluid.

During the diœstrum or intermenstrual period there is very little fluid to be found in the vagina. This scant fluid consists of mucus in which are some atypical squamous cells from the vaginal wall and many leucocytes. A number of the leucocytes are old but there are probably new ones arriving almost continuously from the wall of the vagina. The only time at which the vagina seems to be practically free of leucocytes is immediately before and during the first and second stages of the œstrous period described above.

A marked correlation exists between the œstrous changes in the uterus and the developmental cycle of the corpora lutea. When the corpora lutea are highly developed and apparently active the mucosæ of the uterus and vagina show a normally vigorous and healthy condition. While on the other hand, when the corpora lutea begin to degenerate during the second week after the "heat period" the mucosæ of the uterus and vagina also begin to shown signs of degeneration and the process of desquamation slowly commences. At about two weeks after the last "heat period," when the wholesale destruction of the mucosa begins, the corpora lutea are almost completely degenerated. The breaking of the Graafian follicles occurs during the œstrus as a result of a congestion which began in the theca folliculi at about the same time as the congestion of the stroma of the uterus and vagina. And finally when the regenerative growth of the uterine mucosa sets in, the ovaries then possess new corpora lutea in an active state of differentiation which were derived from the recently ruptured follicles.

It, therefore, might be imagined that the secretion from the corpora lutea exerts a protective influence over the uterus and vagina while the absence of this secretion permits the breaking down and degeneration of the uterine epithelium typical of the "heat period."

C. R. Stockard,
G. N. Papanicolaou

THE IOWA ACADEMY OF SCIENCE

The thirty-first annual session of the Iowa Academy of Science was held at Grinnell College, Grinnell, on April 27 and 28. The opening meeting was called to order on Friday afternoon by President Stewart, of the State University. After the transaction of preliminary business the president delivered his annual address on "Recent advances in physical science and the relation of the Iowa Academy to scientific progress." Professor Conard, of Grinnell, who had been the academy's delegate to the tenth annual meeting of the Illinois Academy of Science, gave a report of that meeting. A number of papers of general interest were read and the president announced that other papers would be read before the appropriate sections, which were: 1, Geology; 2, Zoology and Botany; 3, Mathematics, Physics and Chemistry.

Professor R. A. Millikan, of the University of Chicago, was to have given the annual address, but as he was unable to leave his work on the Council for National Defense, at Washington, Professor S. M. Woodward, of the University of Iowa, gave the address on the "Application of science to flood prevention," an outline of his work on the Dayton, Ohio, flood-prevention project.

Following the meetings of the sections on Saturday morning the business meeting was held, at which the following officers were elected for the coming year.

President—L. S. Ross, Drake University, Des Moines.

First Vice-president—S. W. Beyer, State College, Ames.

Second Vice-president—C. E. Seashore, State University, Iowa City.

Secretary—James H. Lees, Iowa Geological Survey, Des Moines.

Treasurer—A. O. Thomas, State University, Iowa City.

Resolutions were adopted pledging the support of the academy to the President of the United States, also commending the action of the Iowa legislature in passing laws to give quail and prairie chicken a closed season of five years and providing for a board of conservation to investigate localities in Iowa which are of scenic, scientific and historic interest.

PROGRAM

Geology and Allied Subjects

A notable mound group near the proposed government park at McGregor. ELLISON ORR.

(*a*) *Wave action and results of ice action as seen near the Macbride Lakeside laboratory, summer of 1916.* (*b*) *Second record of oscillations in lake level, and records of lake temperatures and meteorology, at the Macbride Lakeside laboratory, July, 1916:* JOHN L. TILTON.

Possible fan structure in Canadian Rockies: CHARLES KEYES.

The Cordillera in Jasper Park, in northwest Alberta, as in other parts of the great mountain chain, is characterized by tremendous thrust planes; but unlike most other portions there is on the east flank a sharp flexing on a large scale. The especially notable feature is the Appalachian or Alpine type of structure. The relationships of the various members are presented with greater perspicuity than anywhere else throughout the entire extent of the Rocky Mountain region, perhaps with greater graphic distinctness than Appalachian structure is exhibited in the whole world. A hundred miles farther south, on the west side of the chain, the pre-Cambrian clastics with steep but variable slants indicate the presence of the other half of the orographic fan.

Glacier dams of central Washington: CHARLES KEYES.

Extent and age of Cap-au-Grès fault: CHARLES KEYES.

A bibliography of the driftless area: W. D. SHIPTON.

(*a*) *The Iowan glaciation and the so-called Iowan loess deposits.* (*b*) *Post-Kansan erosion.* (*c*) *The Buchanan gravels of Calvin and the Iowan outwash:* M. M. LEIGHTON.

The loess and the antiquity of man: B. SHIMEK.

History of the Pleistocene in Iowa: EMMET J. CABLE.

Pleistocene deposits between Manilla in Crawford county and Coon Rapids in Carroll county, Iowa: GEORGE F. KAY.

The most significant features that have been revealed by a study of the Pleistocene deposits in many deep cuts made recently between Manilla in Crawford county and Coon Rapids in Carroll county, by the Chicago, Milwaukee and St. Paul Railway Company, were described.

Ocheyedan mound, Osceola county, Iowa: GEORGE F. KAY.

This brief paper describes the chief characters of the long time famous Ocheyedan mound, which is thought by many persons to be the most picturesque topographic feature in northwestern Iowa.

The mound is a kame which was formed during the recession of the Wisconsin ice sheet.

The esthetic value of such beautiful and interesting geological phenomena as Ocheyedan mound should be fully appreciated by the citizens of the state, and every effort should be made to prevent their destruction. Already Ocheyedan mound has been somewhat marred by the removal at its summit of sand and gravel which was used for commercial purposes. To be sure, the mound is valuable for the many thousands of tons of material that might be taken from it to be used for roadmaking or other purposes, but of far greater value is it to the state as a beauty spot, a landmark, which should be conserved for future generations just as zealously as we are wont to conserve our material resources.

A note regarding a slight earthquake at Iowa City, on April 9, 1917: GEORGE F. KAY.

A supposed fruit or nut from the Tertiary of Alaska: A. O. THOMAS.

The specimen, which was collected in the coal-bearing beds of the Tokun formation, is about 8 cm. in diameter. The symmetrical arrangement of certain meridional and other lines on its surface and attached fragments of what appears to have been an epicarp suggest that it may be a fossil fruit or nut. Other possibilities are suggested.

A large colony of fossil coral: A. O. Thomas.

A coral colony of gigantic proportions was recently discovered in a reef of Niagaran corals in Jones county. Conditions under which the colony occurs, its dimensions and associations, are described. Illustrations.

Notes on a decapod Crustacean from the Kinderhook shale near Burlington: Otto Walter.

Mississippian crustaceans are comparatively rare. An incomplete specimen found imbedded in a hard shaly nodule is described. It seems to be allied to the old genus *Paleopaleomon*.

Some observations on the history of Yangtse River, China: C. L. Foster.

Some geologic aspects of conservation: James H. Lees.

Some of the beauty spots of Iowa are described and their scenic and geologic values are mentioned. The necessity for their preservation is emphasized.

Some fundamental concepts of earth history: James H. Lees.

After a brief discussion of the evidence for progressive development of the material world there is given an outline of the trend of thought regarding the history of the earth. This outline covers the work of leading thinkers from the Greek and Roman philosophers to the great systems evolved by La Place and Chamberlin.

(*a*) *The Prairie du Chien-St. Peter unconformity in Iowa.* (*b*) *The origin of the St Peter sandstone.* (*c*) *Some conclusions concerning the erosional history of the driftless area:* A. C. Trowbridge.

Home Economics

Improved method for home canning: C. N. Kinney and Maurice Ricker.

Suggested use of calcium chloride and other salts in solution in outer vessels of double boilers to raise boiling point in inner vessel.

Experiments in cooking cereals, canning fruit and vegetables indicate that this cheaper device may replace the auto-clav for these purposes, especially when the inner vessel is subjected to slight pressure.

Physics

(*a*) *Certain features of rheostat design.* (*b*) *An interesting case of resonance in an alternating current circuit:* H. L. Dodge.

The absence of relationship between electro-mechanical properties of selenium crystals and their photo-electric emission by ultra-violet light: F. C. Brown and F. S. Yetter.

The X-ray K-radiation from tungsten: Elmer Dershem.

The influence of intensity ratio in binaural sound localization: E. M. Berry and C. C. Bunch.

A peculiar electrically conducting layer on the surface of mica: G. W. Stewart.

On the torsional elasticity of drawn tungsten wires: L. P. Sieg.

The thermal conductivity of tellurium: Arthur R. Fortsch.

(*a*) *Electrical capacity of similar, non-parallel plane plates, and its application where the plates are non-rectangular.* (*b*) *Mathematics of stroboscopy; The strobodeik; Theory of the stroboscopic effect by reflection of light from vibrating mirrors.* (*c*) *Precontact conduction currents:* L. E. Dodd.

Effect of drawing on the density and specific resistance of tungsten: Wm. Schriever.

Effect of gases on unilateral conductivity: Robert B. Dodson.

Zoology and Allied Subjects

Birds of the past winter, 1916–17, in northwestern Iowa: T. C. Stephens.

A list of the birds observed in Clay and O'Brien counties, Iowa: Ira N. Gabrielson.

An annotated list of the mammals of Sac county, Iowa: J. A. Spurrell.

Bell's vireo studies: Walter W. Bennett. (Illustrated with lantern.)

Observations on Bell's vireo, a species of the central United States which has heretofore been little studied. Near Sioux City it arrives unobtrusively from the south during the second and third weeks in May. During nesting, which immediately follows, the bird has been found to sing on the nest after the fashion of the warbling vireo. A tendency of the bird to become easily tamed, a habit of very frequently sitting for long periods in a resting attitude near the nest, and other characteristic actions have been noted. Also, an unusually large proportion of cowbird's eggs in their nests and other facts point to a possible diminishing number of individuals of the species, at least near Sioux City.

An analysis of the cranial ganglia in Squalus acanthias: Sally P. Hughes. (Illustrated with lantern.)

This analysis confirms the results of Strong (1903) and Landacre (1916). The trigeminus ganglion is constricted into a ventral maxillaris and a dorsal mandibular and superficial ophthalmic portion; the ophthalmicus profundus has a distinct ganglion. The facialis comprises the geniculate ganglion, a motor root distributed through the hyomandibular trunk, and three lateral line ganglia—a buccal, a superficial ophthalmic VII., and a third out in the hyomandibular trunk—the fibers from the last two forming the dorsal lateral line root, those from the buccal, the ventral. The auditory ganglion is distinct, rising by a large root just ventral and posterior to the lateral line roots of the VII. The IX. ganglion is visceral sensory with a small lateral line ganglion in its anterior end. The lateral line fibers rise by a small separate root just barely in contact dorsally with the lateral line root of the X. The vagus rises by a large anterior lateral line root followed by a succession of visceral sensory and motor roots. There are three lateral line ganglia on the X., almost fused together. A small general cutaneous element is given off with fibers from the first two of these. The visceral ganglia are also slightly segmented into four branchial and one intestinal portion, the last two quite inseparable. The cervical plexus, comprising the two occipitals and first three spinal nerves, is in contact with the vagus, but entirely distinct from it.

The eyeball and associated structures in the blind-worms: H. W. Norris. (Illustrated with lantern.)

The optical apparatus in the Cœcilians undergoes various degrees of degeneration and transformation, from a condition where the entire mechanism is present, but in a rudimentary condition, to that where only a vestigial eyeball and much modified and transformed retractor and levator bulbi muscle are present.

Bermuda as a type collecting ground for invertebrates: H. A. Cross, Jr.

White grub outbreaks in northeastern Iowa: R. L. Webster.

A brief account of the destructive outbreaks of white grubs in northeastern Iowa in 1912 and 1915; the relation of the contour of the land and the abundance of timber to these outbreaks; the prospects for damage in the near future.

The influence of the male on litter size: Edward N. Wentworth.

Entomostraca of northwestern Iowa: F. A. Stromsten.

The following is a list of Entomostraca collected in the neighborhood of the Macbride Lakeside Laboratory, Lake Okoboji, Iowa, during August, 1916: *Sida crystallina, Daphnia hyalina, Daphnia kahlbergensis, Daphnia Scapholebris mucronata, Simocephalus vetulus, Simocephalus serrulatus, S. americana, Bosmina longirostris, Camptocercus macrurus, Alonella excisa, Pleuroxus stramineus, P. hamatus, P. denticulatus, P. procurvus, Diaptomus sicilis, D. signicauda, D. oregonensis, D. clavipes, D. pallidus, Cyclops signatus* var. *coronatus, C. s.* var. *tenucornis, C. insignis, C. serrulatus, C. macrurus, C. fluviatilis, C. affinis, C. bicolor, C. phaleratus, C. fimbriatus.*

The development of the musk gland in the loggerhead turtle: Frank A. Stromsten.

Some new endoparasites of the snake: Thesle T. Job.

Porocephalus globicephalus Hett; the characters of the male, which Hett did not have in describing the species, are recorded and additional notes on the habits and anatomy of both sexes offered.

A distome, *Renifer sp?*, closely allied to *R. ellipticus* Pratt. Measurements of the specimens recorded.

Larvæ of Acanthocephala, *Gigantorynchus sp?*, larval condition described.

Further notes on the venous connections of the lymphatic system in the common rat: Thesle T. Job.

In addition to the portal, renal and ilio-lumbar vein communications reported in 1915, an inferior vena caval communication at the level of the lumbar nodes has been demonstrated. The variable occurrence of the communications and the lack of correlation of these taps is shown. The possible effect of the physiological condition of the animals and of the injecting technic on the demonstration of the communications is suggested. Conclusions as to the significance of the communications are delayed until the embryological study now in progress is completed.

Mites affecting the poison oak H. E. Ewing.

The Odonata of Iowa: Lloyd Wells.

Observations on the Protozoa, with descriptions and drawings of some probable new species: Clementina S. Spencer.

Notes on some Iowa rodents: Dayton Stoner.

A brief progress report of some work now under way on the rodents of Iowa for the Iowa Geological Survey. Two forms, *Sciurus hudsonicus minnesota* Allen and *Lepus californicus melanotis* Mearns, are for the first time recorded from Iowa and the known distribution of some other species of rodents is extended. A brief survey of the bounty system in the state is also given.

Botany

The Sand-flora of Iowa: B. Shimek.

Some additional notes on the pollination of red clover: L. H. Pammel and L. A. Kenoyer.

The germination and juvenile forms of some oaks: L. H. Pammel and Charlotte M. King.

Plant studies in Lyon county, Iowa: D. H. Boot.

Notes on Melilotus alba: Walter E. Rogers.

The cleistogamy of Heteranthera dubia: R. B. Wylie.

The influence of soil management on the formation and development of fruit buds: R. S. Kirby.

(*a*) *The white waterlily of Clear Lake, Iowa.* (*b*) *Tree growth in the vicinity of Grinnell, Iowa:* H. S. Conard.

A picea from the glacial drift: Wilbur H. Thomas.

Pioneer plants on a new levee, III.: Frank E. A. Thone.

The morphology of the thallus and cupules of Blasia pusilla. Marguerite B. Rohret.

Chlorotic corn: W. H. Davis.

The æcial stage of alsike clover rust: W. H. Davis.

The rusts on clover were formerly classified as one species until Liro proved the rust on white clover (*T. repens* L.) separate, autœcious and possessing all spore forms. The æcial stage of red clover rust was definitely described by Davis and Johnson at a meeting of the American Association for the Advancement of Science, December, 1916. They showed this rust to be autœcious also, and composed of all spore forms. The disposition of the rust on alsike clover has not been clear; some place it with red clover rust while it is generally regarded as white clover rust. The æcial stage has not been reported in the United States, but has been reported in Germany by Rostrup (1888). The correct determination of his host is not generally accepted.

The use of ferric and ferrous phosphate in nutrient solutions: George E. Corson and Arthur L. Bakke.

A series of experiments have been performed using varying amounts of ferrous and ferric phosphate in Shive's solution as a general basis, in the growth of wheat and Canada field pea seedlings. Ferrous phosphate can not replace the ferric phosphate. The amount as used by Shive has been determined to be the best for the growth of wheat, but for Canada field pea the iron requirement is evidently higher.

Chemistry

(*a*) *Some natural waters of central New York.* (*b*) *Diffusion phenomena of double salts:* Nicholas Knight.

Water-works laboratories: Jack J. Hinman, Jr.

A collection of data from ninety water works laboratories in the United States and Canada, safeguarding an average daily supply of 2,800,000,000 gallons for more than 17,000,000 people. All of these laboratories have been established since 1897. Their organization and methods of chemical and bacteriological control are discussed from the technical standpoint.

Laboratory control is essential to the proper operation of water-works plants which treat a water of variable character.

The free energy of dilution of lithium chloride in aqueous and alcoholic solutions by the electromotive force method: F. S. Mortimer and J. N. Pearce.

The electrical conductivity and viscosity of solutions of silver nitrate in pyridine· H. L. Dunlap and J. N. Pearce.

A study of the relation between solubility, the heat of solution and the properties of the solvent: H. E. Fowler and J. N. Pearce.

The partial analyses of some Iowa clays (preliminary report): J. N. Pearce.

The protein content and microchemical tests of the seeds of some common Iowa weeds: L. H. Pammel and A. W. Dox.

(*a*) *Synthesis of a naphthotetrazine from diethyl succinylosuccinate and dicyandiamide.* (*b*) *The behavior of benzidine toward selenic and telluric acids.* (*c*) *Amino acids and microorganisms:* Arthur W. Dox.

The separation and gravimetric estimation of potassium: S. B. Kuzirian.

The action of the amino group on amylolitic enzymes: E. W. Rockwood.

Some of the factors that influence the extraction of gold from ores by the cyanide process: A. W. Hixson.

James H. Lees,
Secretary

SCIENCE

FRIDAY, JULY 20, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y

THE NEXT STEP IN IMPROVEMENT IN WHEAT CROPPING—HOW TO INCREASE WHEAT PRODUCTION IN 1918 AND 1919[1]

YOUR secretary has requested me to prepare a paper on soil organisms affecting cereal production. The subjects which should come before you at this time are without question of the greatest importance to this nation and particularly to the cereal-producing states, and, of these, none are of greater import than those which touch upon the causes of seed and crop deterioration in cereals, under the general cropping and marketing processes now in use. In the case of wheat on the general market it may be truthfully described as yearly more closely approaching the "no grade" condition because of mixtures of kinds and qualities through the jumbling methods of the handling processes. In the case of the seed used on the land in such general cropped regions, the start or first crops produced are always at "No. 1 quality." The finish is always reached after a gradual yearly reduction in purity, vitality and weight quality, until crop failure ushers in seed importation, and then, final failure of the cereals as the chief crops. Are these consequences a matter of necessity?

I am well aware that agriculturists, fertilizer experts, agronomists, and perhaps some plant pathologists, do not agree with me in assigning as great importance to the rôle of plant diseases and to soil and seed sanitation in cereal cropping as I do. However, stock raising, gardening and fruit growing communities have in a large way already adjusted themselves to sanitary methods of agriculture. At the risk of appearing too pointed, I bring to you the thought that it is time that cereal agriculture be adjusted so that the cropping methods known under the heading of tillage, crop rotation and soil fertilization may come into their own and prove their real merits through the agriculturists, agronomists and the cerealists getting together on a program which shall properly take into account the teachings of the soil biologists, plant physiologists and pathologists for the great cereal crops as has been done for flower and vegetable farming, for potatoes, fruit cropping and other types of intensive crop culture. It is notorious that aside from the applications of the principles of seed disinfection for the prevention of smut and a considerable work looking toward the selection of disease-resistant varieties very little in an organized way has been done looking toward putting cereal agriculture on a plane of sanitary cropping comparable to the intensive methods used with the crops mentioned.

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[1] Read before the third Interstate Cereal Conference.

I think you will agree that the present wheat bushelage can not on the average year be greatly increased by just sowing more acres on the same old areas in the same old way or even in the same districts unless a great change is introduced. How wonderful has been the influence of plant pathology on the grape industry, on the fruit industry, on the apple crop and for the potato crop. When we want to grow these in the best way do we forget all principles of soil sanitation or of disease introduction and modes of distribution and infection? If the principles of sanitation associated with proper cropping methods in these more confined crops have been of benefit, what may they not do for the cereal crops when properly applied and adjusted to the cropping conditions of each great cereal district.

Now that the governmental officials have appealed to this country to raise the greatest possible wheat crop, what have we done to get it? We have only advocated the sowing of the greatest number of acres in the quickest possible time. Granted that we were unprepared to do otherwise, shall the process be continued? Every conceivable bushel of every conceivable kind of wheat, mixed, diseased or otherwise, has gone into the soil and into any area available. Nothing more can be done now than to see that the crop is properly harvested so as to save the greatest possible bushelage in the best possible condition to prevent its food value from being injured, and particularly, that it may not be spoiled as seed for the crop of 1918–19. If such better harvesting is to occur, it must take place in a sanitary method. If it is to be done intelligently, there must be a comprehensive plan; and those who handle the crop after it is grown should know that their handling processes are as important as the cropping processes.

Experiments in North Dakota with potatoes, flax, wheat and allied cereals, extending over the period of time from 1890 to 1917, dealing always with the problems of seed disinfection, soil purification and cropping methods for the control of disease, allow me to say with assurance that soil and seed infection has largely accounted for the many anomalous results obtained in various extensive experiments on wheat and cereal cropping, particularly as referring to variety tests, the influence of rotation, methods of plowing, tillage, etc.; for it is now known that through all these experiments in all cereal states there has been acting in greater or less virulence the constant attack of seed- and soil-borne diseases, which have not been properly taken into account. This lack of the proper consideration of sanitary measures as affecting cropping processes accounts chiefly for the reduction of yields and the deteriorated quality of the grain which comes from year to year from the old, rather constantly and extensively cropped cereal areas. I call your attention to the history of wheat cropping in California and in the semi-dry regions of Washington and Oregon as affected by smut epidemics. Ordinarily, in the wetter regions, seed disinfection for the prevention of stinking smut of wheat is all that is necessary. It is not even necessary to have a reasonable crop rotation, but in semi-dry regions the smut spores do not so readily die out by rapid germination; and the combination harvesting and threshing has proved to be a process which quickly undoes the work of possible control of smut through seed disinfection. That process of cutting and threshing the grain and returning the chaff, straw and dust to the soil, evenly distributed, did more than introduce smut. With it goes the spores of a large number of so-called "imperfect fungi," particularly the Helminthosporia and Fusarial types. These and others have brought about seed and root blighting, and with the smut, drought and other conditions soon throws the crop below a paying condition.

In the hard spring wheat regions of Minnesota, North Dakota, South Dakota and Montana, one readily sees the detrimental influences of extensive cereal culture as affecting the introduction, even distribution and destruction by the "imperfect fungi" as transmitted by the seed to new areas, by farming implements, wind and wash waters, and as imbedded in the soil in the dead bodies of the previous crop.

It is a peculiarity of all these seed and soil borne fungi that they are destructive regardless of the year and soil conditions, and vary in intensity according to weather and soil conditions. Thus in intensely dry seasons, particularly preceding the harvest time, old wheat lands often produce almost normal, plump seeds, but when there is sufficient water content in the soil and sufficient rainfall during the heading period to make a normal stand and growth for what should be a large yield, these parasites resident in the seed and in the old stubble lands and often evenly distributed during moist weather from plant to plant, bring about a rag-like condition of the cellular tissues of the straw. They invade it at all parts, and bring about an intense blighting of the flowers and ovules at the time of seed formation so that the heads are never properly filled. Under these conditions seldom any of the grains reach normal form as to color, size and weight.

To call your attention to what I have in mind I can do no better than to quote from some previous publications of mine in this line. From Bulletin 13, North Dakota Experiment Station, 1894, p. 26:

> It is apparent that after all is said concerning culture of wheat in the northwest, haphazard, careless methods of saving the grains at harvest time are yet to be placed as the chief cause in the reduction of the milling quality of the wheat as it now appears upon the market.

From "Plans for Procuring Disease Resistant Crops" in Report of The Society for the Promotion of Agricultural Science, 1907:

> At present the farmers are confused by conflict of authority as to the proper line of seed improvement. For the most part, they believe that seed for crops must be bred to a high standard upon a high-class soil and that it will degenerate when put into general cropping conditions on their farms. . . . The facts remain that crops suffer under systems of constant cropping, while the idea of home grown seed for local crops is fast gaining recognition as right in principle. . . . It is recognized that crop diseases, as well as chemistry of soil and air, play a great, if not master, rôle. . . . Crop yields more often depend upon features of disease resistance, or upon conditions of environment in which disease producing organisms can not be active, than upon whether the soil is especially balanced chemically. Crops fail as often through

> rust, blight, wilt and rot, and insect mites on fertile soils as upon unfertile soils.

From "Interpretations of Results noted in Experiments upon Cereal Cropping Methods after Soil Sterilization," in *Proceedings of American Society of Agronomy*, Vol. 2, 1910:

> Soils and seed may be, and usually are, infected by several destructive wheat-destroying, parasitic fungi. Indeed, these are found to be apparently cosmopolitan in distribution with the wheat plant. They are especially transmitted in the seed internally, and it seems quite certain that they are sufficient in their influence to account for most of the causes of rapid first crop deterioration and for the difficulties which farmers have in introducing any sort of culture, which will again raise the standard of crops. Their exclusion, in so far as it is perfectly or imperfectly done, is sufficient to account for the anomalies in soil sterilization experiments.

From "Conservation of the Purity of Soils in Cereal Cropping," October, 1910, before Dry Land Congress, Spokane, in SCIENCE, N. S., Vol. XXXII., No. 825:

> I recommend both our trained agriculturists and the farmer to look for help from a careful consideration of soil sanitation. . . . I consider it particularly important that this question should be brought before this congress, for this meeting is located at a point west of the center of the last great virgin soil areas of this country. And because, while I recognize the great good that is done by the advocates of the conservation of the chemical qualities of the soil and still remain a strong advocate of the importance of that feature, I feel that we have followed it so persistently as to lose sight of other features which have vitiated many of the conclusions which have been drawn. . . . *My belief is that we must yet be able to produce the bread of the world by the use of extensive machinery and upon extensive plans, such as are yet being carried on in the new lands of the west. I have set forth the reasons why this can not be done unless we recognize this question of soil sanitation, or, if you will, the necessity of conserving the virgin purity of the land.* I am, however, confident that with the proper understanding of the methods which are now known for selecting seed, disinfecting seed, rotating crops and perfecting the seed bed there should be no necessity of growing wheat upon the costly lands now under intensified farming systems, and that there is no immediate necessity of abandoning the cropping to cereals on the large plan which is characteristic of the northwest. I believe firmly, however, if we do not thus recognize this matter of the necessity of soil sanitation and soil disinfection by means of proper cultivation, and well-planned series of crop rotation, that, no matter how fertile the soil of one of your western valleys may be, no distant year will see your crop fall very close to the world average for that particular cereal.

From "Cereal Cropping: Sanitation, A New Basis for Crop Rotation, Manuring, Tillage and Seed Selection," in SCIENCE, N. S., Vol. XXXVIII., No. 973, 1913:

> Deteriorated wheat, as seen in depressed yields and low quality, as now quite commonly produced in the great natural wheat-producing regions of this country, is not, primarily, a matter of lost fertility or of modified chemical content of the soil, but is specifically a problem of soil and crop management. Crop rotation, for example, is not, primarily a farm process which is likely to conserve the fertility of the soil, but when properly arranged in a system so that the proper crops follow one another, it is definitely a sanitary measure tending to maximum production. . . . Wheat does not do well in the presence of its own dead bodies, not because of any changes which the wheat plants have made in the content of the soil fertility, nor because of any peculiar poisons (toxins) which the crops may be thought to have introduced, but primarily, because of infectious diseases which are characteristic of the crop. . . . Proper methods of soil tillage and handling of manures and artificial fertilizers are not merely measures for supplying plant food, but also involve vital features of a sanitary nature. . . . That there is a real problem before the agriculturists of the world, especially as affecting the question of maintaining the output of wheat in amount and quality, all must agree. The present approximate annual output of 700,000,000 bushels in its occurrence is somewhat analogous to the varying annual output of gold. It is maintained at these approximate figures, essentially not through increased yields of grain of better quality per acre on old cultivated areas through certain exact methods, but rather through the breaking up or turning over of new areas, in the same wasteful methods. The most alarming feature of the whole condition rests not so much in these facts as in the evident rapid deterioration of the quality of grain which invariably accom-

panies the first few years of cropping upon new land areas.

All these statements have to do with the fact that wheat in particular and most cereal grains are attacked by certain parasitic fungi which have been usually considered saprophytes or semi-parasites. They attack in such manner as to invade all parts of the plant body, break down the tissues, clog up the ducts, and rot off the roots, and they are particularly destructive as the seedling and stooling stages, and finally cause blighting and shrivelling of seed. We have developed a particularly interesting method of attempting to purify such internally infected wheat grains and other cereals by special methods of heavy seed disinfection, aiming at seed-coat disinfection. The seedlings are then grown upon agar just as one grows a pure culture of a fungus or a bacterium. This allows proper study of the root characters and other conditions as affected by the organisms, and makes it possible to separate uninfected seedlings to be grown on purified soil. This work has been associated with special studies upon soil and seedling purification in many ways. The results of tests extending over a number of years show that continuous cropping to wheat and flax brings about a continuous cumulative infection of soil and seed. In flax the wilt fungus, *Fusarium lini*, remains indefinitely in fertile soil and makes it essentially sterile for that crop. So, also, certain fungi of wheat eat away at the roots and attack seedling plants from the stubble or seed and through accumulation in the seed carry always an accumulating infection to new or cleaned lands, undoing the proper effects of tillage and crop rotation.

A few of the genera particularly concerned in the destructive work upon wheats are *Alternaria*, *Collstotrichum*, *Helminthosporium* and *Fusarium*. Each of these is peculiarly destructive in its own way, and in certain years one or other may excel in the destruction of the crop.

To these attacks the wheat plant reacts as best it can by the growing and sending down of new roots, adventitious or brace roots, as fast as the old ones die. Its fibrous rooting capacity stands it well in hand, with the result that, unlike flax, it usually holds on to the ground and does not give an absolute failure, though a very irregular crop is characteristic. The disease generally known as scab falls under the group known as *Fusarial* infections. These no doubt spread from head to head to a certain extent, but by far the largest amount of damage is done by direct attack upon the roots just as in flax-wilt and other Fusarial wilts. I need not go further into this phase of the subject.

If the diagnosis is correct, we shall never get the full benefits from the campaign for a better agriculture until steps are taken to rather suddenly and generally bring about an actual compliance in better sanitary methods of harvesting the crop and handling the soil and seed.

Mr. Rockwell Sayre, of Chicago, has not been wholly wrong in his campaign for compulsory crop rotation laws. Our people do not like to be compelled to do anything. Perhaps the better method is to educate, but general education comes too slowly to be effective in any sanitary measure. On small areas such as are occupied in potato cropping and in intensive farming propositions the educational process can be brought about and rather effectively carried into operation, but with the great cereal crops where practically three fifths or more of the entire area of a state is put under wheat and allied cereal culture, these diseases, under present methods, run riot.

What to do: It is with a good deal of temerity that I offer the following suggestions. I recommend through this congress to the United States Department of Agriculture that it, in association with proper state authorities, immediately put on an extended wheat crop survey, (1) to insure a proper harvesting and selecting of the fields from which seed is to be saved for the crop of 1918, so that selection may be made on the basis of freedom from disease and purity as to variety; and (2) to save the seed so it shall be as free as possible from water effects following the period of maturity; for it is through moisture that the invasion of the seed coats becomes most active. This invasion prevents ordinary seed disinfection from being effective.

With this seed survey a soil survey should go hand in hand as follows: (1) Map and locate the virgin lands of the wheat states; (2) map those lands which have had crops on them for the last five to seven years which are of such nature as not to bear the chief diseases of the wheat crop, and (3) set aside these virgin or clean lands and prepare them for the wheat crop of 1918 and 1919.

As a corollary to the seed and soil surveys, the United States Department of Agriculture should commandeer and contract for sufficient of the wheat coming from the virgin lands or from the field crop inspected areas of the older regions which are found to be free from disease, to redistribute to the lands which by the survey have been found to be essentially free from the chief diseases of wheat. Finally, there should be put on a campaign of education which shall reach every grower of wheat in the United States.

If this national survey of soil and of seed production is to be done so as to be effective on the crop of 1918, the work should start before the harvest of 1917, and be so continuously followed up that the plowing may be done for next year and the ground prepared for early seeding. Somewhat over one half of all the land of North Dakota has still been untouched by the plow, or at least has not been subject to wheat culture. A similar condition exists in most of the spring wheat-producing states. A proper seed bed for the production of wheat can be made upon this new land if it is broken early in the present summer; and, if it is plowed during any portion of this summer, it can be packed and worked down in fine shape for some crop which is suitable to precede wheat, so that in 1919 the wheat can go into this land without further plowing in the finest possible condition.

To summarize: How shall we improve the bushelage and quality of wheat produced in 1918 and 1919? (1) Put on a field crop survey which will locate seed of highest weight and color quality free from disease infection and weather effects; (2) locate the soils upon which such seed should be seeded; (3) take the proper steps to procure that seed and see that it is sowed. Should the government find it necessary to force a proper consideration of the lands upon which wheat is to be sowed and the use of the proper quality of seed, properly disinfected, it would, in my belief, eventually receive the entire sanction of the American farming and business public and we would learn within two or three years the enormous value which would accrue from proper soil and seed sanitation in the cropping cereals. H. L. BOLLEY

NORTH DAKOTA AGRICULTURAL COLLEGE,
May 30, 1917

SCIENTIFIC EVENTS

AGRICULTURAL EDUCATION AND RESEARCH IN CHINA[1]

CONSIDERABLE attention is now being devoted in China to agricultural education and experimentation in various classes of institutions. An experiment station was located at Peking in 1907 under the control of the board of agriculture, industry and commerce. An experimental tract of nearly 300 acres is available, and departments of crops, soils, animal husbandry, horticulture, floriculture, entomology, botany, forestry, bacteriology and biology have been put in operation. In 1908 an agricultural college was organized in connection with the station, but this was disbanded in 1915.

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[1] From the *Experiment Station Record.*

Subsequently an agricultural college and experiment station was established at the capital of each province along much the same lines as at Peking, and many other stations in addition. There are now reported to be 130 stations in the 22 provinces, of which 31 are in Chihli, 25 in Szechwan, 15 in Hu-Long-Kiang, 7 in Hupeh, and 7 in Kwangtung.

Among these are two cotton experiment stations, one at Cheng Ting Hsien, Chihli, and one at Nan T'ung Chou, Kiangsu, with a third under consideration at Tung Haing Chou, Hupeh. Experiments are being conducted at these stations in seed selection, seed distribution, plant harvesting, soils and manures, treatment of pests and cotton weaving. A corps of students is also being trained at these stations. H. H. Jobson is in charge of the organization of the cotton work, with H. K. Fung as associate.

Stock-raising experiment stations have been established at Kalgan and Shih Men Shan, Anhui. These are expected to study the improvement of breeds of domestic animals, promote the breeding and sale of stock and stock raising enterprises, and the cultivation of forage crops.

Considerable attention is also being devoted to forestry in China. A department of forestry was organized in January, 1916, with a forestry commissioner in each province. Forestry experiment stations and training schools have been established at Ch'ang Ch'in Hsien, Shantung, and in the Temple of Heaven at Peking.

The university at Nanking has maintained a college of agriculture and a school of forestry for several years. This is an American-supported institution, and in 1915 had enrolled about 70 students in agriculture. A colonization association has been organized under its auspices, with provision for the reservation of about 35 acres in each colony for a model farm. A tract already purchased on Purple Mountain, just outside Nanking, is to be used as an experiment station in connection with the different colonies.

An agricultural experiment station was opened at Nanhsuchou, Anhwei, in 1915, as a part of the American Presbyterian mission station. Agricultural work was taken up at this institution partly as a practical way to teach Christianity, partly to make friends and partly to improve economic conditions. The station is located on the railway between Nanking and Tientsin, and attempts to serve an area of about 6,000 square miles and from 1,500,000 to 2,000,000 people. The farming methods in use are those of from one to two thousand years ago. Special prominence is being given in the experimental work to seed selection, better tillage methods, more and better fertilization, drainage and animal husbandry. The work is to be largely of a demonstration nature during the present pioneer stage, and will also include an agricultural school, a school farm and short winter courses for farmers. J. Lossing Buck has been in charge of the agricultural work at the station from the outset.

THE BRITISH METEOROLOGICAL COMMITTEE

THE eleventh annual report of the British Meteorological Committee for the year ended March 31, 1916, states, according to an abstract in the London *Times*, that during the year the staff of all departments of the office was fully occupied in supplying information in reply to inquiries from the various departments of the Admiralty and the War Office. "The results of meteorological inquiries initiated in what appeared to be the remote interest of the theory of the circulation of the atmosphere have turned out to have important practical bearings, and collections of statistics compiled in the ordinary course of meteorological duty have now come in most usefully to meet urgent requirements." "A separate unit of the Royal Engineers has," says the report, "been created for meteorological service in the field. The service with the Expeditionary Force in France is under the command of

Major Gold, one of the superintendents of division in the office, and that with the force in the Eastern Mediterranean under Captain E. M. Wedderburn, honorable secretary of the Scottish Meteorological Society. With him is Lieutenant E. Kidson, a graduate of Canterbury College, New Zealand, who has distinguished himself as magnetician in the service of the Carnegie Institution of Washington, and came to this country to offer his services. In the organization of these meteorological services, the committee has received great assistance from one of its members, Major H. G. Lyons, R.E., formerly director-general of the Egyptian Survey Department, whose services were lent by the War Office in view of the importance of an adequate knowledge of the weather to the proper conduct of naval and military operations in the Mediterranean, to which attention was called by the Admiralty. Major Lyons has taken charge of that department of the work of the Office from May 17, 1915, and more recently he has been appointed to represent the War Office on the committee. The special thanks of the Admiralty for the services of the meteorological officer in the Mediterranean have been received through the War Office. In view of the importance of coordinating the experience of flying officers with the work of the office and observatories in order to obtain more effective knowledge of the structure of the atmosphere for the use of the air services, the committee represented to the director of military aeronautics the desirability of appointing a professor of meteorology to the Royal Flying Corps (with the rank of major during the war). The director of military aeronautics concurred, and the Army Council approved the appointment of Lieutenant G. I. Taylor, R.F.C., to that office. Major Taylor was Schuster reader in meteorology from February 20, 1912. His services were lent to the Board of Trade for meteorological work on the steamship *Scotia*, chartered for the investigation of ice in 1913.

THE WISCONSIN PHARMACEUTICAL EXPERIMENT STATION

At the request of the State Pharmaceutical Association, the Wisconsin Pharmaceutical Experiment Station was established by special legislative enactment four years ago. Its meager budget of $2,500 nevertheless yielded modest results since practically the entire sum was expended in productive work. This was made possible because of the close cooperation of the station with the department of pharmacy of the university.

As a war measure, the present legislature has doubled the income of the station. The pharmaceutical garden has been increased from three to ten acres, with ground that admits of an increase to thirty acres as soon as the means of the station permit. This increase in garden area was made largely at the request of the Office of Drug-Plant and Poisonous-Plant Investigations, which keeps an expert on the grounds, in order that acre experiments of greater economic significance might be carried out.

The station also enjoys a research fellowship of $500 for the investigation of thymol and related problems, established for the academic year 1917–18 by Fritzsche Bros., of New York. Another $500 previously offered as fellowship by the Kremers-Urban Co., pharmaceutical manufacturers of Milwaukee, was utilized toward an endowment fund for pharmaceutical research, a movement, which, like the station movement five years ago, was started by the pharmaceutical alumni of the university.

In addition, the income from $10,328, bequeathed by the wills of the late Mr. and Mrs. Albert Hollister, is available for graduate study and research in the form of the Hollister fellowship in pharmacy.

SCIENTIFIC NOTES AND NEWS

President R. A. Pearson, of the Iowa State College, is acting as assistant to the secretary of agriculture to cooperate with the state boards for food production and conservation.

Dr. Frank M. Chapman, curator of ornithology in the American Museum of Natural History, is now in Washington, where he is director of the Red Cross Bureau of Publications. He is the editor of the newly established *Red Cross Bulletin*, which is designed to keep the public informed as to the activities of the organization.

Dr. C.-E. A. Winslow, of the Yale School of Medicine, is engaged in Red Cross work in Russia. During his absence the editorship of the *Journal of Bacteriology* has been assumed by Professor Leo F. Rettger, Yale University. Manuscripts for the journal should be sent, as heretofore, to Professor Winslow's office, Yale School of Medicine.

Dr. Augustus Trowbridge, professor of physics in Princeton University, has been made director and commissioned a major in the signal corps of the U. S. Army. Under him there is now a staff of twenty-five men working in the Palmer Physical Laboratory.

Leave of absence during 1917–18 for war service has been granted to Professor J. S. Shearer of the department of physics of Cornell University. He is directing the standardization of X-ray apparatus for the medical corps.

Dr. John A. Elliott, associate plant pathologist of the Delaware College Experiment Station, has been elected plant pathologist of the Arkansas Agricultural Experiment Station, to fill the vacancy created by the resignaiton of Professor J. Lee Hewitt, who has become secretary and chief inspector of the Arkansas State Plant Board.

M. Emile Picard, recently elected permanent secretary of the Paris Academy of Sciences, has been appointed to represent the French government on the International Geodetic Association.

M. Ernest Solvay, the distinguished Belgian industrial chemist, who has made large gifts for the endowment of chemical and physical research, has been elected a corresponding member of the Paris Academy of Sciences in the place of the late Sir Henry Roscoe.

General Bourgeois, professor of astronomy in the Paris School of Technology and director of the geographic service of the French Army, has been elected a member of the Paris Academy of Sciences in the Section of Geography and Navigation, to fill the place vacant by the death of M. Phillip Hatt.

The University of Nebraska has conferred the doctorate of science on Patrick Joseph O'Gara, '02, chief in charge of agricultural and smelter waste investigations for the American Smelting and Refining Company at Salt Lake City. For the past four years Dr. O'Gara has been making extensive investigations on the effects of gaseous and solid smelter wastes on vegetable and animal life.

Mr. C. D. Geidel, chemist and bacteriologist in the state food laboratory, Madison, Wis., has accepted a position in the Bureau of Chemistry, Washington, D. C., and assumed his new duties on June 15.

H. K Benson, instructor in industrial chemistry at the University of Washington, Seattle, and director of the Bureau of Industrial Research, will spend his summer vacation at the plant of the American Nitrogen Products Company at La Grande, Wash., where he will conduct research work relating to the manufacture of nitrogen products from the air by use of electricity. Professor Benson will return to his school work in the fall.

Professor C. E. Davis has resigned as professor of chemistry at the Utah Agricultural College at Logan, and accepted a position as research chemist for the National Biscuit Co., with headquarters in the Havemeyer Laboratory, Columbia University.

Mr. L. W. Bahney has left the Sheffield Scientific School of Yale University to take a position as metallurgical engineer with the Scovill Manufacturing Co., Waterbury, Conn.

Professor Lloyd Van Doren, of Earlham College, Richmond, Ind., has been cooperating with The McIntosh Stereopticon Co., Chicago, in the compilation of a series of lantern slides suitable for illustrating topics in general chemistry and in industrial chemistry.

Mr. Burr A. Robinson has resigned as assistant secretary of the American Institute of Mining Engineers to go into industrial work, and Professor G. A. Roush, of Lehigh University, has taken up his work as managing editor of the institute's monthly bulletin.

The following assistants in the American Museum of Natural History have enlisted in the army: Carlos D. Empie and Harold E. Anthony, mammalogy; Charles Camp, vertebrate paleontology; Leo E. Miller and James P. Chapin, ornithology. Howarth S. Boyle, ornithology, is now in the service of the navy.

Dr. Hermann M. Biggs, state commissioner of health of New York, is chairman of a subcommittee on tuberculosis appointed by the general medical board of the Council of National Defense. Other members of this special committee are: Dr. John W. Trask, of the United States Public Health Service; Dr. George T. Palmer, of Springfield, Ill.; Dr. Charles B. Grandy, of Newport News, Va.; Dr. E. R. Baldwin and Dr. Lawrason Brown, of Saranac, N. Y., and Mr. Homer Folks, of New York.

The commission for the prevention of tuberculosis, which the Rockefeller Foundation is to send to France, will, as has already been announced in Science, be headed by Dr. Livingston Farrand, president of the University of Colorado, who for ten years was the executive secretary of the National Association for the Study and Prevention of Tuberculosis. Dr. Farrand will be accompanied by Dr. James Alexander Miller, of New York; Homer Folks, of New York, and Professor Selskar M. Gunn, of Boston. Hermann G. Place, of New York, has been appointed secretary. Dr. Miller is professor of clinical medicine in Columbia University, the director of the tuberculosis work of Bellevue Hospital, and president of the Association of Tuberculosis Clinics in New York City. Holmer Folks is the secretary of the State Charities Aid Association. In addition to his connection with the commission, Mr. Folks will take charge of the tuberculosis relief work of the American Red Cross in France. Selskar M. Gunn holds a professorship in the Massachusetts Institute of Technology, is the secretary of the American Public Health Association, and editor of the *American Journal of Public Health*.

The war council of the American Red Cross announces the appointment of a medical advisory committee, the membership of which is as follows: Dr. Simon Flexner, director of the Rockefeller Institute, chairman; Dr. John W. Kerr, assistant Surgeon General, United States Public Health Service; Dr. Hermann M. Biggs, director of the New York State Department of Health; Dr. William H. Welch, dean of the School of Hygiene, Johns Hopkins University; Dr. Frank S. Billings, professor of medicine, University of Chicago; Dr. M. J. Rosenau, professor of preventive medicine, Harvard University; Mr. Wickliffe Rose, director of the International Health Board; Dr. Victor C. Vaughan, professor of hygiene, University of Michigan; Dr. Charles V. Chapin, Department of Health, Providence, R. I.; Dr. Richard P. Strong, professor of tropical medicine, Harvard University; Dr. Richard M. Pearce, professor of research medicine, University of Pennsylvania. Ex-officio members of the committee will be: Colonel Jefferson R. Kean, director general, department of military relief, and Dr. T. W. Richards, assistant director general, department of military relief. Permanent offices for the medical advisory committee will be opened in the Red Cross headquarters in Washington, in charge of Dr. Richard M. Pearce, who will act as secretary.

"Science and industry: the place of Cambridge in any scheme for their combination" was the subject of the Rede Lecture delivered at Cambridge by Sir R. T. Glazebrook, F.R.S., fellow of Trinity, and director of the National Physical Laboratory.

Charles Horton Peck, former state botanist of New York, died at his home in Albany on July 11. Dr. Peck's official term of scientific service began in 1867, and extended over a period of forty-six years. He retired on account of illness and age in 1913, and at the time of his death was in his eighty-fifth year.

Alois von Isakovitz, an industrial chemist, known for his work on perfumes and flavoring materials, born in Bohemia in 1870, died at his home in Montecello, New York, on June 5.

Edward Randolph Taylor, since 1877 a manufacturer of chemicals at Penn Yan, N.

Y., known for his work on the electric furnace and the determination of carbon in steel, and later for work on the conservation of water for power, has died at the age of seventy-three years.

PHILIPPE DE VILMORIN, known for his work in plant and animal genetics and head of the well-known seed-growing establishment, died on June 30, at the age of forty-five years.

DR. VITALI, formerly professor of pharmaceutical chemistry in the University of Bologna, has died at Venice at the age of eighty-five.

WE learn from *Nature* that the late Lord Justice Stirling's herbarium, consisting chiefly of about 6,000 varieties of mosses and liverworts from many parts of the world, has been presented by Lady Stirling to the Tunbridge Wells Natural History Society.

FREE public lectures will be delivered in the lecture hall of the museum building of the New York Botanical Garden, Bronx Park, on Saturday afternoons, at four o'clock during the summer as follows:

July 7. Wild flowers of summer, by Dr. N. L. Britton.

July 14. Plants grown by the American Indians, by Dr. A. B. Stout.

(Exhibition of Flowers, July 14 and 15.)

July 21. Flowers for the summer garden, by Mr. G. V. Nash.

July 28. How the introduction of foreign plant diseases is prevented, by Mr. H. B. Shaw.

August 4. Floral and scenic features of Cuba, by Dr. M. A. Howe.

August 11. Books on gardening, by Dr. J. H. Barnhart.

August 18. Trees and flowers of the Yellowstone National Park, by Dr. P. A. Rydberg.

August 25. Insect enemies of plants, by Dr. F. J. Seaver.

(Exhibition of Gladioli, August 23–26.)

THE department of physics at the University of Illinois is giving the following popular lectures in the summer session on recent advances in physics:

Professor C. T. Knipp: The production of high vacua; discharge of electricity through gases; electrons and X-rays; the electrostatic and magnetic deflection of cathode rays (electrons); positive electricity.

Professor Jakob Kunz: The electron; Radiation; Photo-electricity.

Mr. Sebastian Karrer: X-rays and structure of crystals.

Mr. C. S. Fazel: Atomic models and chemical properties; Atomic models and radiation.

Mr. H T. Booth: Temperature measurements.

Mr. W. H. Hyslop: Wireless telegraphy.

Professor J. W. Hornbeck (Carleton College): Electromagnetic waves.

Professor F. R. Watson: Acoustics of buildings; Acoustical phenomena.

THE Bureau of Fisheries announces the continuation of the investigation of lakes in Wisconsin, which is directed by Dr. E A. Birge, of the University of Wisconsin. Dr. N. L Gardner, of the University of California, is making a systematic and economic study of the marine algæ of the Pacific coast. A small allotment has been made for investigation of parasites of fishes in Oneida Lake, N. Y., in connection with the biological survey of that lake under the direction of Dr. C. C. Adams, of the New York State School of Forestry. Dr. J. J. Wolfe, of Trinity College, N. C., assisted by Mr. Bert Cunningham, will continue his studies of the plankton collections in Chesapeake Bay made by Lewis Radcliffe in connection with the extended survey of the bay. Mr. Willis H. Rich, of Stanford University, will continue the investigations of the habits and migrations of the Pacific salmons. Dr. J. E. Reighard, of the University of Michigan, will be engaged in studies of the breeding habits of fishes and will also direct investigation of the distribution and habits of salmonoid fishes of the Great Lakes, based in part upon field observation and collections and in part upon a study of scale characters. Among other investigations that will be continued in progress are those of Dr. A. H. Wright, of Cornell University, on the natural history and propagation of frogs, and Professor Trevor Kincaid, of the University of Washington, on the culture of oysters in Puget Sound.

UNIVERSITY AND EDUCATIONAL NEWS

At The Ohio State University, J. A. Bownocker, professor of inorganic geology and curator of the museum since 1901 and state geologist since 1906, has been made head of the department of geology to succeed the late Charles S. Prosser. J. E. Carman, Ph.D. (Chicago), assistant professor, has been made professor of historical geology and curator of the museum, and Arthur Bevan, A.B. (Ohio Wesleyan), for the past two years a graduate student at Chicago, has been made instructor in geology.

Harold Veach Bozell, director of the school of electrical engineering of the University of Oklahoma, who during the past year has been on sabbatical leave studying in Yale University, has been appointed to a chair in the Sheffield Scientific School. Associate Professor Lester William Wallace Morrow, of the University of Oklahoma, has been promoted to succeed Professor Bozell, and T. G. Tappan, now of Cornell University, has been appointed to the position of associate professor of electrical engineering in the University of Oklahoma.

At Oberlin College, Robert E. McEwen, Ph.D. (Columbia, '17), was recently appointed instructor in the department of zoology.

L. D. Batchelor has been appointed professor of plant breeding in the University of California, his work being at the citrus station of the graduate school of tropical agriculture.

Dr. Ernest M. R. Mankey, of the University of Illinois, has been appointed head of a new division of plant physiology at the Delaware College.

DISCUSSION AND CORRESPONDENCE

THE USE OF PREHISTORIC CANADIAN ART FOR COMMERCIAL DESIGN

The Archeological office of the Geological Survey, Department of Mines, Ottawa, is now prepared to show to Canadian manufacturers and their commercial artists a very complete series of several hundred examples of motives for decorative and symbolic designs and trade marks, although it has no facilities for making designs. These motives are all from prehistoric Canadian art and handiwork. Such archeological material supplies not only the oldest human decorative material from Canada, but material unsurpassed in distinctiveness. The fossils, animals, flowers, leaves, fruits, etc., and especially the historic objects from Indians found only in Canada would no doubt supply other motives capable of use as the lotus blossom has supplied innumerable designs used throughout much of the world.

Mr. Joseph Keele, of the ceramic laboratory of the department, has used some of these shapes and motives in the modelling of part of the vases made to test Canadian clays. Many of these pottery products after serving their purpose were given to the Women's Canadian Club, who sold them for the benefit of the Red Cross. At the sale there was a greater call for the vases made after these Canadian motives than for any of the others. Eighteen manufacturers, representing six totally different industries, a museum and an art school have already applied for copies of these motives. This is over 20 per cent. of those informed of the opportunity and one firm has already sent two representatives from Toronto to Ottawa to look into the matter. They express themselves as surprised at the quantity and usefulness of the material and have already selected motives for their designers to use.

This seems to prove that there is a demand for motives or inspiration for new and characteristic Canadian designs and trade marks. This demand we may expect to grow at the close of the war, when Canada makes special efforts to stand on an even footing with other countries in producing manufactures recognized all over the world as individually and characteristically her own.

These motives may be used as they are or may be conventionalized or dissected or multiplied or developed in several of these ways. Designers may use them as inspiration for designs which may be applied to fronts of buildings, gargoyles, fountains, terra cotta, pottery, china, ornamental work, cast iron railings, stoves, carpets, rugs, linoleum, wall paper, stencils, dress fabrics, lace, embroidery, neckware, umbrella handles, jewelry, brooches, silverware, knife, fork and spoon handles, belt buckles, hat pins, book covers, tail pieces, toys souvenirs, trade marks and many other lines of work.

It is hoped to publish drawings of these motives as soon as the drawings can be made. Each drawing will be labeled as to what the specimen is, where it was found, where it is now, its size, material, and, to a certain extent, with the region in which the type of motive is found. The area in which each motive is found is given, so, for instance, that a British Columbian manufacturer may know which motives are appropriate for British Columbian manufactures rather than use one appropriate only for Manitoba. Some of these areas extend into the United States as does the area of the maple leaf and the beaver; others are confined to parts of Canada. Reference is made to photographs, lantern slides, and published illustrations wherever such exist. The actual specimens are scattered in this museum, the Provincial Museum at Toronto, Provincial Museum at Victoria, the Museum of the Natural History Society, St. John, New Brunswick, the Provincial Museum at Halifax, the American Museum of Natural History, New York, the Museum of the University of Pennsylvania, the British Museum and museums in San Francisco, Florence, Italy, Berlin, Germany and elsewhere.

If this publication is issued it will no doubt be sent to every large library, every member of Parliament, every newspaper in Canada, probably, to all Canadian manufactures using designs and certainly to all such manufacturers who express the need for it.

As it may be months before all the drawings can be made the archeological office will make every effort to give free of all expense any practical aid that it can in the use of these motives. These data are at the service of any manufacturer who desires to call at the office. Possibly photographs can be made of a few of the motives for such manufacturers as specify just what they would like to have photographed. A typewritten list of the books containing pictures of some of the specimens will be supplied on request.

The office will do all in its power to hasten this work and will be obliged to manufacturers if they will call or write to offer suggestions and express their needs. Such an expression will very likely be of service to the office in securing the improvement and hasty publication of the album of motives.

HARLAN I. SMITH

GEOLOGICAL SURVEY, CANADA

METHODS AND MATERIALS FOR THE PREPARATION OF WALL CHARTS

VARIOUS grades of paper, with or without cloth-backing, have been used extensively for many years in making charts to be used in lecture rooms. However, unbacked paper does not wear well, and cloth-backed paper is heavy and stiff, besides being expensive.

Shade cloth is cheaper, lighter, and much more durable than any chart paper. One variety known as Holland Shade Cloth is used by several workers in my acquaintance. A large chart of this cloth may be folded into a small package or rolled into a close roll convenient for carrying in a suit case to a meeting in some distant city. When unpacked it requires no heavy sticks to make it hang smoothly.

This cloth furnishes a fine surface for line drawings. The air brush may be used on it in shading, and wax crayons may be employed. However, when large areas of wash shading with a brush are involved, there is a good deal of puckering of the cloth. For this reason, I have made trials of other fabrics in the past three years, and I have found that so-called Peerless Cambric Shade Cloth, Ivory White, is excellent for large wash drawings. It does not pucker noticeably, and it has a good drawing surface. There is no trouble with "drying lines" in applying washes. This cloth is a little heavier and stiffer than Holland cloth, and it can not be packed so compactly without forming creases. I have recently been informed that the puckering may be avoided by mixing equal parts of 80 per cent. alcohol and the ink solution employed.

I have not found it practicable to erase ink marks from shade cloth to any extent, but lead pencil marks are more easily removed than from paper. When a mistake is made with ink that can not be erased, I find it best to paste a bit of the shade cloth over the error. This is not noticeable at the distance of even the front row, in any ordinary lecture room.

For making lines, I find so called round-writing pens (single pointed) better than a ruling pen as it is hard to make lines broad enough with the latter instrument. Round writing pens may be obtained in different widths, and they are inexpensive. The wider pens are useful especially for making bold strong lines to be seen in a lecture room of some size.

Most of my charts are made with waterproof inks of the best grade. These are kept in various dilutions in a series of one-ounce bottles. Thus I keep about six dilutions of black ink in as many bottles labelled one to six, for use in neutral gray shading. A few drops of black ink in an ounce of water make a dark shade. Several drops of this added to an ounce of water in another bottle make a weaker solution, and so on according to the eye of the user.

I dilute the colored inks usually by placing a few drops of ink in an ounce of water, according to the color desired. Many varieties of color shade and tint may be obtained by mixing colors in water and by adding a little much-diluted black ink to a colored solution in varying proportions. It is my practise to dilute almost all of the ink used, to some extent. Softer and more pleasing effects are produced, and the ink goes farther. It is also more easily applied.

For class use and for convenience in storing, I find it desirable to have charts mounted. Two half-round pieces of one inch diameter are glued together with the lower end of the chart between their flat surfaces. To make the binding still more secure, nails are also used. Light one-half-inch half-round material is used for the top in the same way. Straps for hanging, of strong braid one half to three quarters of an inch wide and a foot or so long are fastened to the top strips at suitable places. These also serve in the usual way for tying the charts up when rolled. It is particularly important that the straps be attached strongly.

Some readers of this article may not be familiar with the possibilities of a pantograph in copying small drawings enlarged on charts. The best pantographs are expensive, and the cheapest unsatisfactory. However, I have found one costing about $5.00 of considerable service. It enables one to get the general outlines of the drawing, but these must be corrected by free-hand work later.

Neat labelling, that can be read in the rear seats of the room in which the chart will be used, is exceedingly important. It is my practise both with charts and lantern slides to avoid any details in either labelling or drawing that can not be distinguished easily in the more remote parts of any lecture room in which the illustrations are to be used.

It is distressingly common, especially when lantern slides are employed, to find this rule violated. Large sheets of typewritten material are often crowded into a lantern slide with the result that they can be read only when very near the screen, if at all. In the case of lantern slides, any details which can not be distinguished easily in the slide will also be too minute on the screen. In preparing charts it is a good practise to put letters and drawing details of various sizes on a blackboard which may be viewed from the most distant seats in order to determine the most practicable proportions.

Labelling may be quickly and neatly done with the aid of the so-called sign-painters' rubber stamps. Sets may be bought in various sizes and with both caps and small letters as well as Arabic figures, etc. Inks of various colors may be obtained for the stamping. Quick-drying inks save time in the preparation of a chart.

It is my experience that most and sometimes all the chart work described in this article can be done by student service under direction, especially if students who draw well are available.

Though I am reluctant to appear to advertise dealers, for the convenience of readers I think I am warranted in stating where the materials mentioned in this article may be purchased. The shade cloths may be purchased from the Remiem and Kuhnert Co., 61 W. Grand Ave., Chicago. In September, 1916, I was given a price of 38 cents per yard for "Peerless Cambric Ivory White" shade cloth, 48 inches wide in entire rolls. The price was 44 cents per yard in small quantities. The White Holland shade cloth was slightly cheaper. Dr. G. R. LaRue, of the University of Michigan, has informed me recently that "Linaura Chart Cloth" sold by the Williams, Brown & Earle Co., Philadelphia, is very satisfactory.

For labelling, we are using a so-called "Sign and Price Marker" set, No. 48 in catalogue No. 28 of Meyer and Wenthe, 108 N. Dearborn St., Chicago. The catalogue price is $5.00 for the complete set. It is adapted to charts to be used in large lecture rooms. Set No. 6 at $4.00 and set No. 4 at $2.50 are recommended for smaller rooms. The round writing pens can probably be bought at many art and drafting instrument stores. Mine were obtained of A. H. Abbot and Co., 119 N. Wabash Ave., Chicago, ¼ gross for 25 cents.

R. M. STRONG

ANATOMICAL LABORATORIES,
VANDERBILT UNIVERSITY MEDICAL SCHOOL

THE ELEMENTARY TREATMENT OF FORCE

THE discussion by G. S. Fulcher in SCIENCE, XLIV., 747, 1916, concerning some of the errors and inconsistencies in our elementary texts regarding the questions of force and Newton's laws of motion, are most timely. No doubt many of us who are trying to build up in the minds of our beginning students a sound structure of physical ideas, and above all, are hoping through physics to give them something of the scientific attitude, have almost despaired of finding a text which is free from the faults mentioned. To approach the ideal, a text should be brief in its statements but so explicit as to allow of but a single interpretation; it should not anticipate knowledge which obviously the beginning student does not possess, nor should it attempt to circumvent this deficiency by repeatedly referring the student to articles further along; it should, in fact, be written upon the premise that the only source of physical ideas which the average beginning student of physics has is his own experience.

In introducing force, therefore, all speculation and conjecture, made in the light of the author's own familiarity with the subject, is decidedly out of place, and can serve only to confuse the student. It should be presented to him primarily in terms of his immediate impressions, *i. e.*, in terms of his muscular sense. Let us tell him first that "force" is the term applied to the equivalent of a push or a pull. The average student has pretty clear ideas as to what such an action can accomplish. It is then not difficult to represent Newton's first law as a test for the absence of a force, nor the second law as a test for its presence. After familiarity with these notions has been gained, we can further represent the second law as a quantitative test for force, and can show how we can experimentally establish the relation $f = ma$. This may then be regarded as a more exact definition of force, derived from our observations upon objects external to ourselves. In all of this discussion it is of greatest importance to emphasize by repetition the fact that *whenever a force is exerted, two bodies are involved A, the body acting, and B, the body acted upon.*[1] This is one of the outstanding points which have been disregarded in our texts. The result has been that in a large number of cases the student did not see *how* the force was being exerted; he felt that there was an intangible something about force beyond the range of his ability to grasp. It is small wonder that rapidly increasing confusion results from this lack of self-confidence.

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[1] In his reply (SCIENCE, XLV., 480, 1917) to A. H. Patterson (SCIENCE, XLV., 259, 1917), which was printed after the present paper had been submitted for publication, Dr. Fulcher has already emphasized this point.

In this connection, may I suggest that we discontinue the use of the phrase, "a force acts upon . . .," which is so exceedingly common in our texts? It seems to me that the phrase attributes to force a property which it does not possess. Why not be unequivocal and say "a force is exerted upon . . "? This latter way of stating the fact serves better than the former in keeping the above italicized principle before the student, in that it deprives the notion of force of that seeming independence which does not pertain to it.

Another point can not be too strongly emphasized. No author of an elementary text seems as yet to have recognized the importance of distinguishing most carefully between forces of action and forces of reaction. It seems to me of prime importance, if the student's ideas about force are to be sharply outlined, to make this distinction. I would suggest that it lends facility to the treatment to use the terms "applied" force and "reactive" force for forces of action and of reaction, respectively. The following treatment may bear out the contention concerning the importance of recognizing both.

Let us first apply Newton's third law of motion to the case of a body *A*, acting upon a fixed body *B*. In this case the student readily understands that *B* exerts a reactive force equal and opposite to the applied force exerted by *A*; for if this were not true, motion should ensue in accordance with the second law. He also readily sees that the reactive force arises and ceases simultaneously with the applied force. Often, however, when the third law is applied to a movable body *B*, and the student is told that the accelerated *B* exerts a reactive force upon *A*, equal and opposite to the applied force exerted by *A*, he is dubious and asks: "If that is true, how can there be an acceleration? By the first law, *B* should then remain at rest or in uniform motion." With the distinction between applied and reactive forces clearly drawn, this question can not arise. In this particular case we may point out that, to be sure, no acceleration of *B* could occur if the force exerted by *A* upon *B* were opposed by another applied force, exerted upon *B* in the opposite direction by a third body, *C*. However, since there is only the one applied force, that due to *A*, acceleration must ensue in accordance with Newton's second law; and, *simultaneously with this acceleration, ergo, with the applied force, there arises the reactive force of B upon A*. We may, to present the case somewhat more tangibly, speak of the applied force as being exerted by that particular body which, so to speak, takes the initiative in the processes. It is well to point out, further, that the reactive force of *B* upon *A* arises regardless of whether the motion of *B* is in the direction of the force exerted by *A*, or whether there is a finite angle between these two directions. If this angle is a right angle, the applied force causes *B* to move in a circular path, without change in speed; the applied force is then called centripetal. The reactive force exerted by *B* upon *A* under these conditions is called the centrifugal force, which disappears at exactly that instant which marks the disappearance of the applied force. Numerous examples to illustrate these statements will occur to the teacher.

If the student is familiar with the above principles, the problem of Atwood's machine becomes very simple. For here considering the moving system as a unit, the applied force of *A* (the earth) upon *B* (the system) is obviously $(m_2 - m_1)g$; the reactive force of *B* upon *A* is $(m_2 + m_1)a$. These, by the third law, are equal. The value of a, or of g, immediately follows from the equality.

I can not quite agree with Dr. Fulcher that the failing of our authors in treating reactive forces, especially centrifugal force, as they do, is because of "their forgetting that these forces are purely imaginary." Is it not rather attributable to their previous neglect in not having emphasized the difference between applied and reactive forces?

Just an illustration, in conclusion, to show that American writers do not alone fall under the criticism of giving insufficient thought to the presentation of some of the fundamental things. We find, for example, in a German text, widely used in the Realschulen, by an author reputed to have been one of the foremost teachers of physics, a treatment as follows: "Upon the liquid particle *A* there are acting two forces, the force of gravity, vertically downward, and the centrifugal force, acting horizontally. . . . The resultant is found by the parallelogram law. Its direction must be normal to the surface of the liquid." Had this author, and our American authors, been careful to draw the distinction between applied and reactive forces, they could not easily have fallen into the error of combining an applied force with a reactive force and obtaining—what kind of a force? Whatever the kind, it can not be an applied force; for if it were, it should, according to the second law, produce an acceleration in its own direction. But such an acceleration, as pointed out by Dr. Fulcher, does not here exist.

There are many other fundamental questions in physics about the best method of presentation of which we are not agreed. Teachers of college physics should welcome the opportunity of discussing them, and by so doing, clearing up their own ideas about them. Perhaps, also a thoroughly satisfactory text might thereby be evolved.

PAUL E. KLOPSTEG
UNIVERSITY OF MINNESOTA

QUOTATIONS

ROYAL SOCIETY FELLOWSHIPS

A QUESTION of more than ordinary interest and importance is involved in the opposition of a majority of the Fellows of the Royal Society to a proposal of its council to amend the statute of the society governing the election of fellows. On June 7 a special general meeting of the Royal Society was held, as the result of a petition to the council, to consider a proposal by the latter embodied last year in their report for 1916. It was to amend Statute XII. by empowering the council to recommend for election (*a*) privy councillors "whose election would assist the work of the society"; and (*b*) "men distinguished in the scientific or educational service of the state, or by their services to science and its applications." The opposition to this proposal, led by Sir David Bruce and Sir E. Ray Lankester, had been energetically whipped up among the unofficial fellows since last November, and there was an unusually large attendance at the meeting. The result was that a vote was taken, adverse by a considerable majority to the council. The following resolution was carried: "That this meeting is of opinion that the council will serve the best interests of the society by restoring Statute XII. to the form it had before the change made in it by the council on November 2, 1916, and by postponing further consideration of the statute relating to the election of fellows until after the termination of the war." The precise effect of the action thus taken by a majority of the fellows is for the moment rather uncertain, and the position is a somewhat embarrassing one for the president and council, who have thus suffered an apparent rebuff. According to the constitution of the Royal Society, the power of making and amending its statutes resides solely in the council, so that, strictly, the resolution is a *brutum fulmen*. On the other hand, the actual election of fellows rests with the society, and the council can only recommend candidates. So that the council is hardly likely to provoke an unseemly opposition to candidates it might recommend for election under the amended statute—even if it declines to stultify itself by "restoring" the *status quo ante* as suggested—by flying in the face of the adverse vote.

We understand that the president and council were, in fact, quite ready to meet the opposition raised within the society so far as concerns a postponement of any action on the amended statute till after the war. And in the comment we propose to make we can not, partly for that reason, express our entire disagreement with the opposition too strongly at this juncture. At the same time we think it desirable to say at once that we think the hostility of so many fellows to a proposal intended to increase the prestige and the value of the Royal Society distinctly regrettable. It was based, we are well aware—at any rate among some of the more eminent fellows who led the opposition—largely on suspicions of the introduction of state patronage into scientific research. But we have no doubt also that the influence of "vested interests" in the existing system of election to the coveted distinction of

F.R.S. has been even more potent in securing the majority against the proposal of the council. What we are quite certain about is that for a long time past the elections to the fellowship of the Royal Society have (largely through this influence of "vested interests") got far too much into a groove. The honor of being labelled F.R.S. has gradually come to be regarded more and more simply as a higher "degree" added to the academic distinctions of men who have passed through the regular scientific "mill" and have contributed a certain number of papers to the *Transactions*. The result is that the Royal Society is not as fully representative as it ought to be of the genius of the country, to which, as in earlier days, its fellowship should be extended. This is particularly true of "men distinguished in the scientific or educational service of the state," the importance and originality of whose work for the nation have secured much more adequate appreciation in consequence of the light thrown on it during war-time. A more elastic procedure in the recommendations to fellowships has for some time past been seen to be called for by the wisest heads in the society, and the proposal of the council was the outcome. We hope that it will still be pushed, with more persuasive effect, even though for the moment nothing further is done.

NOTES ON CANADIAN STRATIGRAPHY AND PALEONTOLOGY

CORDILLERAN PROVINCE

Graham Island.—The Queen Charlotte Islands form part of the outer, largely submerged ranges of the northwestern Cordillera and are generally considered to be the northern continuation of the Vancouver Range. Graham Island is the largest and one of the most northerly of the group. Its geology is the subject of a memoir by MacKenzie.[1] The oldest rocks exposed on the island belong to the Vancover group and are divided into two formations, the Maude and the Yakoun. The former consists of argillites, sandstones, and tuffs; it contains a marine fauna of early Jurassic age and at two localities in the lower beds are "probably Upper Triassic" forms. The Maude formation contains a large amount of pyroclastic material in its upper portion and grades upward into the Yakoun volcanic agglomerate, composed of rather massive water-laid beds. Its marine fauna, largely pelecypods and ammonites, suggests correlation with Middle Jurassic sandstones in Alaska. Both formations are moderately metamorphosed and considerably disturbed by folds and faults. They are cut by batholithic intrusions which may be correlated with the Upper Jurassic Coast Range batholith. The orogenic movements causing the deformation of the Vancouver group manifested themselves as compressive stresses acting in a direction north 60° east and were concomitant with these intrusions.

Erosion during Comanchean time reduced the mountain ranges thus formed to a subdued topography which was buried beneath the Queen Charlotte series in the Cretaceous period. That series consists of the Haida sandstones and coal-bearing shales, the Honna conglomerates and sandstones, and the Skidegate sandstones and shales, named in ascending order. It is probable that the Queen Charlotte series was formed in estuarine basins by the sudden influx of a large amount of sediment carried in by rapid streams, and that the series as a whole represents a delta deposit reassorted and modified by the waves and currents of a shallow sea. During the Laramide revolution the rocks of this district were slightly folded and upraised; dacite and andesite dikes and sills were extensively injected. Following this uplift, the Cretaceous sediments were largely stripped from the underlying rocks, remaining only in synclinal basins.

Shallow-water sediments forming the Skonun formation were deposited during the Miocene period. Sedimentation was cut short by the resumption of volcanic activity on a tremendous scale, by which the Masset formation was built up. This vulcanism is best placed in the early or mid-Pliocene, and the close of this epoch was marked by a recurrence of deforming forces which locally severely flexed the Tertiary formations but in general disposed them in broad open folds. Quaternary time has been marked by erosion, glacial as well as fluvial, and there are some suggestions of a recent, slight, negative movement of the strand line.

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[1] J. D. MacKenzie, "Geology of Graham Island, B. C.," Geol. Surv., Canada, Mem. 88, 1916.

A valuable correlation table of formations of Graham Island and neighboring districts faces page 118 of this excellent report.

Flathead Valley.—The Flathead coal basin, occupying a portion of Flathead Valley in British Columbia near the international boundary, is described in another memoir by the same author.[2] Bedrock formations range from strata which are probably Devonian to those of Eocene age. At the base are black limy sandstones and shales which have not yet yielded identifiable fossils but are referred to as "Devono-Carboniferous." Grey and black limestones conformably overlie the shales and range in age from Upper Mississippian to Lower Pennsylvanian, according to Girty's interpretation of two lots of fossils obtained from the middle and near the top of the formation. Above these limestones a white, quartzose sandstone was found. It is provisionally referred to the Triassic because of its position beneath the Fernie shales which elsewhere have been proved to be of Jurassic age. (The lithologic similarity between this Triassic (?) sandstone and the Jurassic La Plata sandstone of Colorado is noteworthy.) The Fernie formation is conformably overlain by the coal-bearing Kootenay sandstones and shales. The Kootenay beds were "accumulated in a long lake of varying depth, or, more probably, in a chain of lakes and swamps extending along what is now the axis of the Rocky Mountains." They are of Lower Cretaceous (Comanchean) age. Upper Cretaceous conglomerates and sandstones are believed to represent the Dakota formation. Orogenic disturbance during the Laramide revolution was followed by the deposition of the Kishinena formation during Tertiary time. The Kishinena beds are of freshwater origin and may be of Eocene age.

CAMBRIAN

Trilobites.—A recent number[3] of Walcott's memoirs on Cambrian Geology and Paleontology contains descriptions and figures of several trilobites, some of them new, from the Lower and Middle Cambrian of Newfoundland, Quebec, Alberta, and British Columbia. *Corynexochus senectus* serves to correlate the upper beds of the *Olenellus* series of Newfoundland with the top of the Mount Whyte formation in the Lower Cambrian of British Columbia. A new subgenus of *Corynexochus* is named *Bonnia,* and to it are referred two closely allied species, one from the Mount Whyte formation and the other from the Lower Cambrian of Labrador and Quebec. To the genus *Bathyuriscus* are referred a new species from the Stephen formation near Field, B. C., and a new subgenus, *Poliella,* which comprises several small-tailed trilobites. Most of them are of Middle Cambrian age, but one occurs in the Mount Whyte formation and lived near the close of Lower Cambrian time. *Dolichometopus* and *Ogygopsis* receive thorough treatment and *Olenellus gilberti* is transferred to the genus *Mesonacis* on the basis of data derived from a Mount Whyte specimen. A new genus, *Pagetia,* is founded upon material from the Burgess shale member of the Stephen formation near Field.

New Brunswick.—A brief but important paper by G. F. Matthew[4] contributes to knowledge of the paleogeography of eastern Canada in early Cambrian time. The relations of Cambrian rocks in New Brunswick are presented in tabular form. At the base is found the non-fossiliferous Coldbrookian terrane, composed largely of volcanic rocks, overlain by the Etchiminian slates and sandstones with a scanty fauna of *Hyolithes* and *Obolus.* The overlying Acadian division of the St. John group is much more extensive because of sea transgression. The lower fifty feet of this division contains the *Protolenus* fauna which Walcott interprets as marking the passage beds between Lower and Middle Cambrian. Above are shales and slates, 200 feet thick, carrying the *Paradoxides* fauna. The middle division, Johannian, of the St. John group consists of coarse clastics characterized by the presence of *Lingulella,* while the upper one, Bretonian, is largely dark gray to black shale which is in part of Ordovician age.

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[2] J. D. MacKenzie, "Geology of a Portion of the Flathead Coal Area, British Columbia," Geol. Surv., Canada, Mem. 87, 1916.

[3] C. D. Walcott, "Cambrian Trilobites," Smithsonian Misc. Coll., Vol. 64, pp. 303–456, 1916.

[4] G. F. Matthew, "Notes on Cambrian Faunas," No. 12, *Trans. Roy. Soc. Canada.,* Ser. 3, Vol. 10, Sec. 4, pp 45–54, 1916.

Emphasis is laid upon the complete separation of the Atlantic coastal seas from those of the interior of North America during early Cambrian time, and "the presence of a deep and broad abyss off the Atlantic coast in this early time" is postulated.

Ontario.—The Potsdam sandstones which outcrop in the vicinity of Kingston are described by M. B. Baker[5] in a report which in the main treats of pre-Cambrian geology. Two members, a lower buff, and an upper red sandstone, are recognized as forming the Potsdam formation. Both were deposited in the basins and hollows between low rounded hills of pre-Cambrian rock. Basal and other conglomerates are common. Cross-bedding is frequently observed and the strata are nonfossiliferous. The so-called "tree concretions" are interpreted as structural accumulations resulting from whirlpools and eddies.

ORDOVICIAN

Ontario.—Fossils from the Trenton limestone in the the Balsam Lake region are described by Ruedemann.[6] A new species of graptolite is referred to the genus *Inocaulis.* Unusualy well-preserved specimens of *Stenaster salteri* confirm the suspicion that this

Faunal Relations	Manitoulin Island	Toronto-Hamilton	Kingston	Ottawa Valley
	Whitewater Saluda Waynesville } Richmond	Queenston		Queenston
		Richmond		Richmond
	Wekwemikongsing Sheguiandah	Pulaski Eden } Lorraine		Lorraine
		Utica		Gloucester
	Collingwoood	Collingwood		Collingwood
Minnesota Prosser				Upper Picton
				Lower Picton
	Prasopora zone		Trenton	Trenton
Kentucky Curdsville	Stromatocerium zone Curdsville Trenton			Hull
Watertown, N. Y. | Decorah, Minn	Black River		Decorah zone	Rockland
	Leray		Leray	Leray
	Lowville		Lowville	Lowville
			Pamelia Rideau	Pamelia
				Aylmer

FIG. 1. Correlation chart of Ordovician strata in Ontario. Compiled from papers by Foerste, Parks, Kindle and Raymond.

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[5] M. B. Baker, "The Geology of Kingston and Vicinity," Ontario Bur. Mines, Ann. Rept., Vol. 25, Pt. 3, pp. 1-36, 1916.

[6] R. Ruedemann, "Paleontologic Contributions from the New York State Museum," New York State Mus. Bull. 189, 1916.

remarkable stelleroid belongs to the subclass Aulnroidea. It is believed to be a primitive ophiuroid, which was still very close to the ancestral asterozoans.

The Ordovician strata of Ottawa Valley are described in summary style by Raymond.[7] The formational nomenclature and relationships are indicated in the accompanying table. Gloucester is a new formation name applied to the carbonaceous shales between the Collingwood and Cincinnatian strata. In correlating the Ottawa formations with those of New York, Kentucky, and Minnesota, Raymond makes a number of radical departures from the conclusions of Ulrich and Bassler. In certain details, the correlation chart[8] is not in complete harmony with the statements made on the accompanying pages of text, as, for example, in regard to the faunal relations of the Kentucky Curdsville.

The limestones of the Kingston district are described by Kindle.[9] The formations recognized are indicated in Fig. 1, which departs from Kindle's usage only in the separation of the Decorah zone as a distinct stratigraphic unit above the Lowville-Leray. The term, "Rideau," originally proposed by Ami[10] in terms which, in the reviewer's opinion, include the Potsdam sandstone described by Baker as noted above, is applied to the green-tinged, arkosic and generally conglomeratic, shaly beds at the base of the Pamelia formation. Accompanying the description of Ordovician strata is a report upon their faunas by Miss Wilson and K. F. Mather.[11] Faunal lists and descriptive keys to the common fossils are aranged in two parts, one for the Black River and the other for the Trenton rocks.

Quebec.—The district about Lake St. John at the head of Saguenay River in Quebec is of interest to the stratigrapher because of the occurrence of Paleozoic sediments far within the limits of the Pre-Cambrian "shield" of northern Canada. These outliers, described by Dresser,[12] are preserved in a basin formed by normal faulting which may have occurred at the close of the Paleozoic Era. The sediments include Trenton limestone, Utica shale, and Richmond limestone, said to be "deposited in conformable succession."

Fossils from the Trenton and Utica were identified by Raymond. The Trenton fauna is preponderantly molluscan and is probably basal Trenton, "about the horizon of the Rockland beds of the Ottawa district." The Utica fauna is small and not distinctive. According to Foerste, the Richmond faunas correspond to those of the Waynesville member of the Ohio Richmond.

SILURIAN

A star-fish from the Arisaig series at the mouth of Stonehouse brook, Nova Scotia, is described by Ruedemann[13] as a new variety of *Urasterella ruthveni* of the Upper Ludlow in England.

DEVONIAN

E. M. Kindle[14] records the occurrence of limestones containing a Devonian coral at Gull Lake, in the lower MacKenzie Valley, where published data show only Cretaceous and pre-Cambrian terranes. Two other small collections of Devonian fossils from MacKenzie Valley, one from within the Arctic circle, are commented upon.

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[7] P. E. Raymond, "The Correlation of the Ordovician Strata of the Baltic Basin with those of Eastern North America," Harvard College Mus. Comp. Zool, Bull, Vol. 56, pp. 179–286, 1916.

[8] Raymond, *op. cit.*, p. 257.

[9] E. M. Kindle, "The Ordovician Limestones of the Kingston Area," Ontario Bur. Mines, Ann. Rept., Vol. 25, Pt. 3, pp. 37–44, 1916.

[10] H. M. Ami, "Ordovician Succession in Eastern Ontario," Geol. Soc America, Bull., Vol. 13, pp. 517–518, 1902.

[11] Alice E. Wilson and Kirtley F. Mather, "Synopsis of the Common Fossils of the Kingston Area," Ontario Bur. Mines, Ann. Rept., Vol. 25, Pt. 3, pp. 45–66, 1916.

[12] J A Dresser, "Geological Structure of the Basin of Lake St. John, Quebec," *Trans. Roy Soc. Canada*, Ser 3, Vol. 10, Sec. 4, pp. 125–130, 1916; "Part of the District of Lake St. John, Quebec," Geol. Surv., Canada, Memoir 92, 1916.

[13] *Op. cit.*, p. 46.

[14] E M. Kindle, "Notes on Devonian Faunas of the MacKenzie River Valley," *Am. Jour. Sci.* (4), Vol. 42, pp. 246–48, 1916.

CARBONIFEROUS

R. L. Moodie[15] reprints, in his monograph of Pennsylvanian amphibia, descriptions and figures of the remarkable microsaurs from the Joggins coal fields in Nova Scotia, which were published by Dawson between 1860 and 1895.

TRIASSIC

L. M. Lambe[16] has published descriptions of three new fishes, two Paleoniscids and one Crossopterygian, from localities west of Banff. The strata have heretofore been assigned to the Jurassic period[17] but are more correctly correlated with the Upper Banff shale on the basis of invertebrates associated with the fish remains. The Upper Banff fauna, according to Girty and Kindle, represents the horizon of the Lower Triassic Meekoceras beds of Idaho and Wyoming. It should no longer be referred to the Permian.

CRETACEOUS-EOCENE

The geology of the region about Wood Mountain and Willowbunch, adjoining the international boundary south of Moosejaw, Sask., is described by Bruce Rose.[18] The strata exposed range from the Fox Hills and Pierre Cretaceous through the Lance formation to the Fort Union Eocene. The latter contains lignitic coal of value. An excellent description of the Prairie Plains of Saskatchewan and their Quaternary history forms the second chapter of the report.

New types of duck-bill dinosaurs from the Cretaceous of Alberta are described by Brown.[19]

MIOCENE

A new species of cyprinid fish, based upon four specimens discovered by Bruce Rose of the Canadian Geological Survey near Kamloops Lake, B. C., is described by Hussakof.[20] It has considerable resemblance to *Leuciscus balteatus* living to-day in the Columbia basin.

KIRTLEY F. MATHER

QUEEN'S UNIVERSITY,
KINGSTON, CANADA,
March 5, 1917

SPECIAL ARTICLES

THE VITALITY OF CYSTS OF THE PROTOZOON, DIDINIUM NASUTUM

IT is well known that many of the unicellular forms encyst under certain conditions, *i. e.*, become inactive and form a heavy wall about themselves, and that in this state they can endure environmental conditions which are otherwise fatal. For example, the loss of water readily kills didinia when they are in the active state, but when they are encysted desiccation such as is produced by exposure even for months to ordinary atmospheric conditions does not necessarily kill them. This is also true of many other forms. When they are thus dried they may be widely scattered by the wind; encystment consequently may have a twofold function, protection and distribution. Whether or not it functions still further in rejuvenescence in accord with the contention of Fermor (1913) and Calkins (1915) is a question which will be considered at some length in a later paper.

The degree of protection and the extent of distribution that organisms secure by encystment depends upon the vitality of the cysts. The longer they live the greater the protection and the wider the distribution. It is consequently important to know how long organisms can live in the encysted state. This is especially true regarding pathogenic forms, and these forms are the only ones, with the exception of the rotifers, in which the problem has been seriously investigated. Knowledge regarding the endurance of cysts may also throw some light on the nature of protoplasm in that it gives information concerning the lower limit of metabolism necessary for life.

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[15] R. L. Moodie, "The Coal Measures Amphibia of North America," Carnegie Inst. Washington, Pub. 238, 1916.

[16] L. M. Lambe, "Ganoid Fishes from near Banff, Alberta," *Trans. Roy. Soc. Canada*, Ser. 3, Vol. 10, Sec. 4, pp. 35–44, 1916.

[17] J. A. Allan, "Bankhead to Golden," Cong. géol. internat., Guide Book 8, Pt. 2, p. 191, 1913.

[18] Bruce Rose, "Wood Mountain-Willowbunch Coal Area, Saskatchewan," Geol. Surv., Canada, Mem. 89, 1916.

[19] Barnum Brown, American Mus. Nat. Hist., Bull., Vol. 35, pp. 701–708, 1916.

[20] L. Hussakof, "A New Cyprinid Fish, *Leuciscus rosei*, from the Miocene of British Columbia," *Am. Jour. Sci.* (4), Vol. 42, pp. 18–20, 1916.

In a series of experiments made in connection with other work on *Didinium* described elsewhere, it was found that the cysts live much longer than had been anticipated. On June 11, 1910, several didinia, all derived from the same individual, were put into a 100 c.c. beaker containing 50 c c. of solution with numerous paramecia. The beaker was then placed in a damp chamber and left until January 15, 1911. At this time many didinia cysts were found in the beaker, and no active organisms except a few rotifers. It is not known just when these cysts were formed, but, judging from what usually occurs under similar circumstances, they were probably all formed within a week after the didinia had been added to the culture of paramecia, *i. e.,* about the middle of June, 1910.

On May 31, 1911, a 10 c.c. vial was filled with solution from the beaker containing about one half the cysts. The vial was then corked, sealed airtight with paraffin and laid away in a dark drawer. The remaining cysts were added to a portion of a vigorous culture of paramecia, and the rest of this culture was retained as a control. Two days later there were several didinia in the portion seeded with cysts, none in the control, showing that the cysts were still viable. A few cysts were removed from the vial and similarly tested on each of the following dates: October 22, 1912; January 23, 1914; December 12, 1914; January 7, 1915; March 1, 1915, and March 4, 1915. In all of these tests except two, December 12, 1914, and January 7, 1915, active didinia were secured from the cysts. No didinia were found in any of the control cultures. This proves conclusively that the cysts of *Didinium nasutum* can live, at least, nearly five years.

In all of the tests observations were made daily. In the test of October, 1912, active didinia were found on the fifth day after adding paramecia, in those of January, 1914, on the second day, and in those of March, 1915, on the sixth and tenth days respectively.

In each of these tests, except the first two and the last, four watch glasses containing cultures of paramecia were seeded with the cysts. In the last test, March 4, 1915, all of the remaining cysts were added to two liter jars containing vigorous cultures of paramecia. In the test of January, 1914, didinia appeared in three of the watch glasses, in those of December, 1914, and January, 1915, in none, although observations were made for more than two weeks; in those of March 1, 1915, active didinia appeared in only one of the four watch glasses; but in the last test of the series they appeared in both jars. In one of these jars only a few small specimens were found and these soon died out; in the other, however, the didinia appeared to be perfectly normal; they developed rapidly and produced a vigorous culture which is still in existence, February, 1917.

It is thus evident that some of the cysts were still viable at the close of our experiment, which extended through nearly five years, but it is not clear how much longer they could have remained viable. However, at the close of the experiment the cysts were much shriveled, only partially filled with protoplasm, and yellowish in color, whereas in the beginning they were well filled with protoplasmic granules and grayish in color. Toward the close of the experiment the proportion of failures was also much larger than at the beginning. All this indicates that the cysts would probably not have lived much longer. On the other hand only a very small proportion of the cysts developed in any of the tests, probably not more than two per cent. Consequently, since the cysts became less numerous as the experiment proceeded the large proportion of failures toward the close may have been due to an insufficient number of cysts rather than to their age.

We have thus demonstrated conclusively that didinia in the encysted state can live nearly five years in a solution from which they probably get nothing in the nature of food. If the cysts are dried they probably live even longer than they do in a solution as the results of the following series of experiments show.

Early in the spring of 1910 ten eight-liter battery jars nearly full of solution containing numerous didinia were set aside in the laboratory. Eight of these jars were covered and two were left uncovered. The solution of one of these contained much débris, hay, etc., that of the other almost none. The solution in both evaporated gradually, so that on the last day of May there was only a trace of moisture left in either jar. When they were next examined early in August the debris was so dry that it could be readily crumbled between the fingers.

On January 14, 1911, one half of the solution in each of the eight jars was poured off and replaced by hay solution (1 gm. hay to 200 c.c. water boiled ten minutes), and the two empty jars were half filled with the same solution. All of the jars were then examined from time to time until February 10. Active didinia were found in only one of the jars, and this was one of the open jars, the one which contained much debris. Several active didinia were found in this jar January 17 and more later. Numerous colorless flagellates, some vorticellæ and also a few other forms appeared but no paramecia.

The results of these experiments, consequently, clearly indicate that the vitality of dried cysts is greater than that of wet cysts. The number of cultures tested was, however, so small that the siginficance of the results obtained is somewhat doubtful. The tests should be repeated and extended in connection with a study of the histological changes that may occur in the cysts.

S. O. Mast

The Johns Hopkins University

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

The 121st regular meeting of the Botanical Society of Washington was held in the Assembly Hall of the Cosmos Club at 8 P.M., May 1, 1917, with thirty-nine members present. Mr. Burt A. Rudolph, Mr. Glenn C. Hahn and Mr. Horace W. Truesdell were elected to membership.

The regular program was devoted to a symposium on the flora of the District of Columbia. Professor A. S. Hitchcock discussed "The plan of the flora" and traced briefly the history of the flora from Brereton's studies in 1831 to the present time. In 1906 a mimeograph list of the vascular plants was prepared by Mr. P. L. Ricker. The flora is now under the leadership of Professor A. S. Hitchcock and Mr. P. C. Standley. Twenty-five collaborators are now at work preparing the preliminary manuscript which is to be finished by June 1 and the manuscript completed by November 1, 1917.

Mr. Edgar T. Wherry, at the invitation of the society, furnished a paper on "Geological areas about Washington." The paper was read by Mr. Hitchcock. The prominent geological feature is the Fall Line which separates the Piedmont Plateau on the northwest from the Coastal Plain on the southeast. Above this line the valleys are steep-sided, and below broad and open. The Piedmont Plateau consists chiefly of crystalline gneisses of early periods, while the Coastal Plain is occupied by unconsolidated gravels, sands and clays. The soils on the Coastal Plain are acid for the most part while those on the Piedmont are not.

Mr. George B. Sudworth discussed "The distribution of trees in the floral area." Oaks predominate and constitute from one half to three fourths of the upland cover. There are about 140 species of native and naturalised trees of which the broad-leaved trees number about 122 species.

"Humus as a factor in plant distribution" was discussed by Mr. Frederick V. Coville. Mr. Coville exhibited two samples of organic matter—the one a raw, brown and leafy turf found in laurel thickets produced chiefly by the decay of the laurel leaves, and the other a black, fully-reduced, non-structural leafmold formed by leaves high in lime content such as the tulip poplar. The former is acid and the latter alkaline in reaction.

Mr. P. L. Ricker discussed briefly the subject of "Collecting and preparing specimens." Mr. Ricker exhibited several types of portfolios suitable for collecting plants and also suggested the use of corrugated driers and artificial heat, especially where large numbers of plants are being collected on field trips.

The program was followed by an informal discussion by Messrs. Safford, Beattie, Norton, Waite, Lewton, Shantz, Coville, Hitchcock, Sudworth and Ricker.

H. L. Shantz,
Corresponding Secretary

SCIENCE

FRIDAY, JULY 27, 1917

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ACIDOSIS[1]

I

FOR many years students of metabolism, of general physiology and of pathology have been investigating various aspects of the acid-base equilibrium of the body, always with an eye to the problem of acidosis, but at first with small success in unifying our knowledge of that complex subject. Successively it has been shown that in acidosis there may be a production of β-oxybutyric acid or some other specific defect of metabolism, an increase of the urinary ammonia, a diminution of the total carbonic acid of the blood, and of the blood's bicarbonate, an increase of its concentration in hydrogen ions, a diminution in the concentration of carbon dioxide in the alveolar air and of the free carbonic acid in the blood, an impairment of the affinity of the red corpuscles for oxygen, and a depletion of the alkali reserves of the body. Not all of these changes, however, are invariably present, and much confusion has resulted from the attempt to distinguish essential or primary phenomena.

At length it has become clear that acidosis is, from the standpoint of physical science, no simple and unitary state or process, but that, like metabolism or respiration, its unity is biological or functional, and that it consists in any disturbance, large enough and so long enduring as to be properly called pathological, of the regulation of alkalinity in the body. What are the disturbances to which this regulatory process is liable? They are such as are made possible by its normal and essential peculiarities and general characteristics. These peculiarities can only be the object of special physiological investigations and the subject of special physiological knowledge. But in great part the more general characteristics are those of all organic regulations, and at this very point organic regulation is to-day best understood and analyzed. Accordingly, the description of acidosis must rest upon a clear definition of the nature of organization itself; it may then, in turn, help to define the larger problem.

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[1] The Samuel D. Gross lecture, 1916.

This conclusion points straight back to Aristotle, whose great attainments as a zoologist together with his extreme virtuosity in conceiving and applying abstract ideas and formulas led him to an analysis of organization that remained the best for more than two thousand years. The words of Aristotle are as follows:

> The animal organism must be conceived after the similitude of a well-governed commonwealth. When order is once established in it there is no more need of a separate monarch to preside over each several task. The individuals each play their assigned part as it is ordered, and one thing follows another in its accustomed order. So in animals there is the same orderliness—nature taking the place of custom—and each part naturally doing his own work as nature has composed them. There is no need then of a soul in each part, but she resides in a kind of central governing place of the body, and the remaining parts live by continuity of natural structure, and play the parts Nature would have them play. ["De motu animalium," II., 703^a, 30–35, Oxford, 1912.]

This statement surpasses the efforts of the modern philosophers, who either have not understood the problem at all, or, like Leibnitz and Kant, have but imperfectly conceived it. The earlier modern biologists are also inferior to Aristotle, for when they have perceived the riddle of organization, it has led them into sterile vitalistic theories or mere bewilderment. But during the last century there took place a steady improvement in the biological analysis and lately the subject has been partly cleared of misunderstanding, so that it is to-day in the minds of most thoughtful investigators.

In the nineteenth century the concept of *organization* appears for the first time as an explicit postulate of scientific research. Of course there has never been a period when the idea of *function* was absent from physiological investigation. And it would be an almost hopeless task to trace the transformation of this idea, with widening experience, into the larger one of organization. Provisionally it may therefore suffice to note the conscious and deliberate use of the latter idea in Cuvier's so-called law. According to this hypothesis it is possible after a careful study of any one part of an animal, for example a tooth, to reconstruct the whole. Nothing could correspond more perfectly with Aristotle's original position concerning the organic relation between the parts and the whole.

Physiology was more deliberate in setting up the principle, because organic activity is harder to define and to describe. At least as early as the time of Johannes Müller the idea was clearly grasped. But not until the establishment of experimental morphology did it become overtly a guiding principle of physiological research. One very important influence toward this result is to be found in the speculations of von Baer.

The truly Aristotelian idea of internal teleology of the organism is at the bottom of von Baer's biological philosophy. Bichat and he are the first of the *organicists*. Their successor is Claude Bernard. This great man, whose purely mechanistic researches stand at the foundation of many departments of physiology, steadily exerted all his influence in favor of the idea of organization. He recognized a directive and organizing idea in the animal, and again and again insisted upon it. Yet his analysis of the problem, like that of von Baer, was not complete. Though he, like all other physiologists, employed the idea of functional activity as a guide in research, though he was fully aware of Cuvier's method in paleontology, his just concern for the integrity of physiological method beguiled him into declaring that "the metaphysical evolutive force by which we may characterize life is useless in science, because, existing apart from physical forces, it can exercise no influence upon them."

This, strange to say, is an old error of Kant's. It is as if one should declare that the idea of the periodic system of the elements is useless to science, because, existing apart from the physical forces, it can exercise no influence upon them. What Claude Bernard well knew, but failed here to point out, is that organization, like the second law of thermodynamics, is a condition of those physio-chemical phenomena which were the subject of his investigations. At times, however, he stated the case more correctly.

During the later years of von Baer and Claude Bernard, the ideas of Darwin were accomplishing a revolution in general biology. Not the least important result was at least temporarily to establish adaptations as the most positive of realities. Yet an adaptation is only to be defined in terms of organization. In the orthodox Darwinian view it is that which contributes to the preservation of the whole. There is nothing in its merely physical character which enables us to recognize it as an adaptation. Only its function reveals its true nature.

In the course of time some of Darwin's original positions have been weakened and the more extreme views of his followers overthrown. As a result this manner of thinking about adaptation is somewhat out of fashion. But it endured quite long enough to leave its mark upon several departments of the science. And it is very doubtful if any one will be bold enough ever again to put aside the idea of function itself or to deny its necessary implications.

Meanwhile a number of independent lines of investigation have arisen from Darwin's researches. One of the most interesting of these is the study of experimental morphology to which Sachs gave an impetus. This subject appears to have developed, partly at least, as the realization of a program of research founded upon Roux's quasi-philosophical analysis of the characteristics of life.

Such a process is a genuine curiosity in the history of science. According to Roux the living being may be defined as a natural object which possesses nine characteristic autonomous activities, *e. g.*, autonomous excretion, autonomous ingestion, autonomous multiplication, autonomous transmission of hereditary characteristics, etc. This conception, as Roux admits, is closely related to Herbert Spencer's famous conception of life as "the continuous adjustment of internal relations to external relations." Roux's discussion of the subject was independent of Spencer's influence and, in its specification of conditions, his analysis possesses certain advantages over the English philosopher's more abstract statement. But, from the standpoint of physical science, it is gravely deficient in method and has never been regarded as more than a preliminary statement of the several physiological aspects of the fact of organization.

What has given Roux's investigation a certain value and influence is that there is thus presented, however dogmatically, a provisional discrimination of organic activities as a basis for the experimental physiological study of organization itself. With the foundation of experimental morphology the problem of organization assumes its proper place in physiological research. The experimental results of the new science clearly prove that the place is secure.

This department of science has developed independently, and only in recent years can its influence upon the older science of physiology be detected. The physiologists, in their more abstract and more analytical researches have usually dealt exclusively with physical and chemical phenomena. Unlike Roux's followers, they have been concerned with those things which are organized in the living being, rather than with the organization of them. Their very method of research, which proceeds from a preliminary analysis of the factors of organization, has obscured the larger biological problem.

At length Pavlov's researches on the glands of digestion, the study of internal secretions and hormones, Sherrington's investigation of the integrative action of the nervous system, Cannon's study of the emotions, and many other independent lines of investigation have cleared the ground, and at the present moment the physico-chemical treatment of the problem of organization is widely, if somewhat vaguely, recognized as the ultimate goal of physiological research. An interesting statement of the present condition of physiology in this respect may be found in Haldane's little book "Mechanism, Life and Personality." It is doubtful, however, if all the philosophical conclusions that Haldane draws can be regarded as well founded.

In the study of metabolism, which has also had an independent development, the idea of organization has long dominated research. This is due to the fact that here the concept of equilibrium can not be avoided. At an early period in the history of the science it was discovered that a normal organism is in a state of nitrogen equilibrium. That is to say, the composition, in respect of compounds of nitrogen, is steadily preserved, through the regulation of a long chain of intricate chemical processes. Day by day the ingestion of nitrogen is approximately equal to the excretion. A modification of the diet may cause a temporary disturbance of the condition, but this is soon restored. The phenomena of growth and disease are found to involve more enduring changes. Hereupon by a process of reasoning patterned upon that of physical science, growth is declared to involve nothing more than other phenomena superimposed upon the underlying conditions, thereby modifying the observed facts in such manner that the fundamental state is partly obscured. And disease is after all, in its very essence, a disturbance of organization; in short, diseases of metabolism involve by definition disturbances of equilibria, which may or may not be compensated.

Further research reveals similar equilibria concerning carbon, sulphur, phosphorus and the other elements. The results are extended to definite chemical compounds such as water, salt, sodium bicarbonate, glucose and the like. It is perceived that the equilibria of temperature, of volume, of alkalinity, which involve physico-chemical states, are truly analogous phenomena.

Meanwhile it has always been clear that within certain limits the existence of these equilibria is essential to the preservation of life itself, and that they might have been taken for granted. The real question has been to define the normal and pathological fluctuations, their duration, their limits and their relations to other phenomena. In short, so far as these problems are concerned, the study of metabolism has consisted in an attempt to describe as thoroughly as may be, and if possible to explain, the fluctuations of the approximately constant physical and chemical conditions of the body. In other words, the task of the investigator has been to make known the facts concerning the regulation of the ultimate physical and chemical constitution of the organism. In this undertaking he has always kept in mind the idea that the organism exists in a state of dynamic equilibrium, just as it was long ago conceived by Cuvier, and more vaguely by Hume, and by Lucretius.

Now this idea of regulation, so familiar in the investigations of the temperature of the body, and in many other general problems of metabolism, is the very concept to which all the other independent investigations of organization as a physiological problem also lead. Thus Roux has long since declared, and recently reasserted the belief, that the capacity of autonomous regulation of all nine of his elementary characteristics is quite the most important of all the peculiarities of life. For example, he thinks that this is what makes possible the direct adaptation to the environment, or, in other words, the acquiring of characteristics. In like manner the action of hormones, the integrating function of the nervous system, and the phenomena of emotional excitement investigated by Cannon are all regulatory.

It is now possible to see that Herbert Spencer's conception of life as "the continuous adjustment of internal relations to external relations," though doubtless far from satisfactory as a characterization of life itself, is really a true statement of the phenomena of organization. Vague though it may be, it is confirmed by the results of experimental morphology, of physiology and of the science of metabolism, and I suspect that pathology affords some of the most striking justifications for such a view. Indeed pathology has its prerogatives, and of these not the least is to follow up the disturbances which, step by step, result from a single lesion or deranged activity until they close a vicious circle, to note the compensatory changes, regenerations and repairs that oppose this process, and thus to perceive the organism as a whole acting so as to preserve that state of dynamic equilibrium which is essential to life itself.

But Spencer's formula is at best imperfect and needs to be modified in order to conform more exactly to Aristotle's thought. Perhaps we may say that life is to be conceived as the continuous adjustment of internal relations to the state of the organism as a whole in accordance with changes of internal and external relations. Yet I can not believe that such formulas are of much account. What we need to know and always to remember is that organization qualifies the body mechanisms. They *are* mechanisms *and also* they are organized. It is in no sense a form of vitalism that is implied in this statement, nor can I think it, as Haldane believes, antimechanism. While I am in hearty agreement with many of Haldane's positions, I can not but repudiate this view. Yet a doctrine essential to all genuine biological progress does arise from this statement, and we are all indebted to Haldane for making it clear and insisting upon it. This doctrine teaches a very necessary truth concerning our present problem of acidosis, viz., that there is no one process or phenomenon which is the fundamental or essential one, but that each is integral, at once as cause and as effect in a cycle of pathological changes whose onset may be at any one of many points and which as a whole, as a cycle, constitutes the deranged acid-base metabolism. But this, moreover, is not the whole of the matter, for, just as the parts of this cycle engage in the whole of the process of acid-base metabolism, so do they also engage, as parts, in other processes, some of them in the respiration, some in the process of excretion, and so on indefinitely. Thus the condition known as acidosis can only be truly conceived in terms of the organization of the body as a whole. Such is the abstract nature of the subject; with this the known facts correspond.

II

From its very beginning, Arrhenius's theory of ionization emphasized the peculiar importance of the ions of hydrogen and hydroxyl. As products of the electrolytic dissociation of water these ions must be present in all aqueous liquids. As products of the dissociation of acids in one case and of bases in the other, they must be essential factors, or at least the only constant factors, of acidity and alkalinity in aqueous solutions.

Methods for the estimation of the concentration of these ions were presently found, and before long successfully, if rather roughly, applied to physiological problems. Thus it was proved that the reaction of blood is nearly neutral and very constant.

Meanwhile the theory was extended, with the help of the mass law, until it became a quantitative theory of acidity, neutrality and alkalinity. The principal results of this development of the subject, so far as they concern the biologists, are as follows:

First, the product of the concentrations of hydrogen and hydroxyl ions (at constant temperature) is approximately constant.

$$(\overset{+}{H})\ (\overset{-}{O}H) = c.$$

Therefore the concentrations of these two ions always vary inversely.

$$(\overset{+}{H}) = \frac{c}{(\overset{-}{O}H)}.$$

Secondly, if for convenience, just as the histologist uses microns instead of meters, we adopt as unit concentrations of hydrogen and hydroxyl ions a very small quantity, viz., the concentration of these ions in neutral solutions, the value of this constant becomes unity.

$$(\overset{+}{H})\ (\overset{-}{O}H) = 1,$$

$$(\overset{+}{H}) = \frac{1}{(\overset{-}{O}H)}.$$

It may be noted that, using this unit of concentration, an ordinary decinormal solution of hydrochloric acid has a concentration of hydrogen ions of nearly 1,000,000; and a decinormal solution of sodium hydroxide a corresponding concentration of hydroxyl ions. Other common dilute acid and alkaline solutions are only less remote from the concentrations of neutral solutions and of blood.

Thirdly, upon this basis the definitions of neutrality, acidity and alkalinity are as follows:

For neutrality,

$$(\overset{+}{H}) = 1 = (\overset{-}{O}H).$$

For acidity,

$$(\overset{+}{H}) > 1 > (\overset{-}{O}H).$$

For alkalinity,

$$(\overset{+}{H}) < 1 < (\overset{-}{O}H).$$

Finally, in any solution containing a weak acid and its salts with one or more bases, regardless of the other components of the solution, the concentration of hydrogen ions is approximately proportional to the ratio of free acid to combined acid.

$$(\overset{+}{H}) = k\frac{HA}{BA}.$$

This relation, however, holds only when the ratio of acid to salt is neither very large nor very small.

It is therefore evident that in the solution of any weak acid, when the quantities of free and combined acid are equal, the value of $(\overset{+}{H})$ is k; if the ratio of acid to salt be 10:1, $(\overset{+}{H})$ is $10\,k$, if the ratio be 1:10 $(\overset{+}{H})$ is $0.1\,k$.

This is the total outcome of the theoretical analysis so far as it is necessary for a general understanding of the biological problem.

We may now turn to the special case of carbonic acid. For this substance the value of k, expressed in our present units, is about 5. Accordingly, in a solution of carbonic acid and bicarbonate, if the ratio of acid to salt be 10 the concentration of hydrogen ions must be 50, if the ratio be 1 the concentration will be 5, and if the ratio be 0.1 the concentration will be 0.5.

Thus we can see why carbonate solutions are almost always nearly neutral (*e. g.*, $100 > (\overset{+}{\mathrm{H}}) > 0.01$), and, taking account of the universal distribution of free and combined carbonic acid in the ocean, in lakes and streams, and in all organisms, we understand the primary cause of the approximate neutrality of nearly all natural solutions, both organic and inorganic, upon the earth. In blood the concentration of hydrogen ions is about one third of the present unit, hence the ratio of free to combined carbonic acid must be less than 1·10.

In general it is evident that when the value of k for an acid is nearly 1 solutions containing that acid and its salts will be nearly always neutral; but that if the value of k differs largely from 1 such solutions will be nearly always appreciably acid or alkaline.

Beside carbonic acid, there is but one biologically common acid substance, viz., phosphoric acid after one hydrogen has been neutralized by base as in acid sodium phosphate, that possesses the value of k nearly equal to 1. Most weak acids have a value hundreds or thousands of times greater. Phosphate solutions are therefore commonly nearly neutral, and they share with carbonate solutions the function of preserving the constant alkalinity of the body.

It is easy roughly to demonstrate the general character of such acid-base equilibria with the help of the phosphates. Thus, for example, a solution of acid sodium phosphate has a faintly acid reaction, a solution of ordinary sodium phosphate an alkaline reaction, but almost any mixture of the two salts is neutral to ordinary indicators, and will take up strong acids or alkalis in large quantities without apparently changing its reaction. Of course every drop of acid or of alkali does change the reaction, but the change is so slight that it can not be detected by ordinary means. This depends upon the fact that strong acids and bases combine quantitatively with the alkaline or acid phosphate:

$$\mathrm{HCl} + \mathrm{Na_2HPO_4} = \mathrm{NaCl} + \mathrm{NaH_2PO_4},$$
$$\mathrm{NaOH} + \mathrm{NaH_2PO_4} = \mathrm{Na_2HPO_4} + \mathrm{H_2O}.$$

Accordingly, there is only a change in the ratio between the concentrations of the two phosphate salts, and of hydrogen ion concentration in due proportion, according to the analysis already given.

If the solution is supposed to contain bicarbonates, as well as phosphates, the above experiment fully illustrates the general character of the process by which acids are immediately neutralized in the body. The proteins, to be sure, are also involved, but their share in the process is small, though not physiologically insignificant.

Upon this physico-chemical basis the physiological processes are erected. It is as a means of restoring bicarbonate and alkaline phosphate from the products of reaction of these substances with acids, or as a means to neutralize acid, and thus prevent its reaction with bicarbonates and phosphates, that ammonia is produced in the metabolism.

In like manner the acidity of the urine is the result of the reversal in the kidney of the reaction by which acids have been neutralized in the body. In the renal function phosphates almost alone are concerned. Therefore the process may be described as follows: In the blood, as the result of the production of acid, a certain amount of alkaline phosphate has been converted into acid phosphate, so that the ratio of acid phosphate to alkaline phosphate has been slightly increased. (Under normal circumstances this change is probably infinitesimal.) The kidney now removes relatively a still larger amount of acid than of alkaline phosphate, perhaps on account of changes in the blood bicarbonate rather than in the phosphate, and thus restores the ratio of base to acid in the blood. Here the essential factor is the ability of the kidney widely to vary the ratio of acid to alkaline phosphate without large variation of the hydrogen ion concentration of the urine. This very important fact once more depends upon the favorable value of *k* for acid phosphate.

It is because, in the normal individual, both the production of ammonia and the ratio of acid to alkaline phosphate in the urine are variable within wide limits, and can be made to conform exactly to the varying ingestion and production of acid in the body, that the fundamental physico-chemical apparatus can be kept intact and accurately adjusted.

A further factor in the process is the activity of the lung in excreting carbonic acid. This substance is the chief excretory product of the organism. As such it must be eliminated promptly and completely. Moreover, in that it leaves the body not in aqueous solution and as an acid, but almost exclusively in the form of gaseous carbon dioxide, there is no possibility of any variation of the permanent effect produced upon the reaction of the body by the elimination of a definite amount of it. In the final regulation by excretion it is not, therefore, concerned. And yet it has, in the process of excretion, a very important rôle in regulating the reaction of the body. This depends upon the fact that carbonic acid is not only a waste product, but also a normal constituent of the blood, and, as such, a principal factor in the physico-chemical regulation. Thus, if the ratio of carbonic acid to bicarbonates in a normal individual were 1:15, a large production of acid might cause a destruction of a third part of all the bicarbonates, producing in its place an equivalent amount of free carbonic acid. This, if nothing else occurred, would reduce the relative amount of bicarbonates from 15 to 10, and simultaneously increase the free carbonic acid from 1 to 6. The ratio would now be 6:10, and since the hydrogen ion concentration is porportional to this ratio, this ion would suffer a nearly ten-fold increase of concentration. But at this point, or, more strictly speaking, continuously during the process, the excretory function intervenes. There is a tendency for the respiratory process to hold the tension of carbonic dioxide in the blood nearly constant. This is the reason why carbonic acid has sometimes been thought the respiratory hormone. Assuming that the exact quantity of carbonic acid set free by the reaction of neutralization were thus eliminated, the ratio would be reduced to 1:10, and the hydrogen ion concentration would rise but one third above its original value. More recent investigations, however, have shown that a tendency to acidity is accompanied by a lowering of the tension of carbon dioxide. Let us suppose that in this case the tension was lowered one third. The free carbonic acid of the blood would then become 0.67 instead of 1.00, and the ratio of acid to salt 0.67:10, which is exactly equal to 1:15, the original ratio. Accordingly, the hydrogen ion concentration would be restored exactly to its original value, and the regulation by excretion would be quite perfect. Now there is abundant evidence to show that something very much like this is always occurring in the body, and, on the whole, I believe that the most delicate of all means to regulate the reaction of the body is to be found in this variation of the tension of carbonic acid during its excretion. Such considerations have strengthened the hypothesis that the hydrogen ion is the true respiratory hormone. Originally suggested as a guess, this theory has been supported by many investigations. But I think that it marks the opening rather than the closing of a chapter in physiology, for the subject is involved in many complexities.

The whole physiological equilibrium may now be concisely summed up. The hydrogen ion concentration of the body has been seen to depend upon the ratio

$$\frac{H_2CO_3}{NaHCO_3}.$$

Acid reacting with this system causes a diminution of the denominator and an increase in the numerator of the fraction, the value of the fraction increases, and with it the hydrogen ion concentration. Hereupon the lung reduces the value of the numerator by diminishing the concentration of carbon dioxide in blood and alveolar air, the value of the fraction is restored more or less exactly to its original value and with it the concentration of the hydrogen ion. But the denominator is still below normal. To offset this, there occurs, on the one hand, a production of ammonia which takes the place in the urine of alkali existing as salt in the blood. This alkali recombines with carbonic acid, forming bicarbonate, and thus increasing the denominator. On the other hand, the kidney removes less alkali in combination with phosphates than exists in this state in the blood. This alkali, too, helps to regenerate sodium bicarbonate, and thus to increase the denominator. Both of these processes are so regulated that the denominator is restored to normal. The concentration of carbonic acid responds through the activity of the respiratory mechanism, and the organism returns to its normal state.

These processes, of course, go on simultaneously and not in succession. They are, moreover, far less simple than such an analysis admits, for on the one hand the interaction of phosphates and proteins has not been fully described, and, on the other hand, many of these variations influence other conditions and processes in the organism.

Among these effects are the influence of carbonic acid concentration and of the hydrogen ion on the affinity of hemoglobin for oxygen and on the volume of the red corpuscles. More general is a necessary, but at present indeterminate, effect on the distribution of electrolytes in the body, on the osmotic pressure, on the state of colloids, and on the volume. I fully believe that such effects are real and that when acid is produced through long periods and in large quantities in particular organs or tissues, as during diabetes, they may well surpass the direct effects of the simple chemical reactions of acid in the pathological complex, and produce a condition very different indeed from that of experimental acidosis. For in such conditions the whole physico-chemical composition of the cell, its concentrations and colloidal equilibria, might be sensibly altered.

But such guesses are one thing and the detailed and very dogmatic speculations of Dr. Martin Fischer quite another. And I feel obliged to say that there is not one particle of evidence for his conclusions, which are indeed inconsistent with, or totally without bearing upon, all the existing quantitative information that we possess upon this subject.

III

What then is acidosis? Evidently a condition lacking necessary connection with the production of oxybutyric acid or with the magnitude of the hydrogen ion concentration in blood; still less a condition involving the existence of acid in the blood. It is often characterized by high urinary ammonia, but sometimes this quantity is low; the concentration of carbon dioxide in the alveolar air is commonly low, but one can not feel sure that this is invariably the case; in acidosis the oxygen capacity of the blood seems to be generally diminished, but we do not yet understand this subject well enough to be sure that compensatory changes may not take place. Upon the whole I think that we come nearest to certainty if we say that acidosis must involve a depletion of the body's alkali reserves, and specifically a depletion of the bicarbonate of the blood. So long as this has not taken place the pathological condition can not amount to much, so far as the acid-base equilibrium is concerned; when this defect is established the whole chain of causation, involving breathing, oxidation, nitrogen metabolism, renal activity and so on, has been set in motion.

The cause of the condition may vary widely. It may be due to the production of acid, or the ingestion of acid, or to lack of alkali in the food; it may be due to failure to eliminate acid, *e. g.*, acid phosphate, or to failure to produce and eliminate ammonia; but so far as can be seen it must always involve at least a diminution in the concentration of bicarbonate in the blood. As a practical maxim, we are therefore fully justified in saying that acidosis is a state of diminished bicarbonate in the blood.

Accordingly, it may also be said that the best means to the recognition of acidosis is proof of diminution in the bicarbonate of the blood. It is true that alveolar air, or the oxygen capacity of the blood, or the urinary ammonia, or the acidity of the urine, or the excretion of acetone bodies, may be definitive in any particular case. But a state of acidosis is certainly not always dependent on some of these variables, and may possibly be independent of all of them.

The most direct proof of diminution of the bicarbonate of the blood is afforded by an estimation of the capacity of the blood for carbon dioxide at a specified tension of the gas. This, or a related method, properly employed, will always give accurate information and need not make considerable demands upon the technical skill of the investigator.

But there is another method, consisting of a physiological test of the greatest simplicity and involving no experimental skill at all, which seems often to lead to equally trustworthy conclusions. The test depends upon an observation made by Sellards and also by Palmer and myself that in different pathological conditions and in different individuals the amount of soda administered by the mouth that is necessary to make the urine alkaline is a very variable quantity. Further extensive investigations of Dr. Palmer's have convinced me that this phenomenon depends on nothing but the retention of alkali by an organism whose store has been depleted, until the normal amount has been once more acquired. The addition of five or ten grams of soda to the food is enough to make the urine of a healthy person alkaline, and if more than that is retained, experience justifies the conclusion that a state of acidosis exists.

This test also points to a rational treatment of acidosis. For if sodium bicarbonate is administered at frequent intervals in quantities just sufficient to make the urine as alkaline as the blood, acidosis can not exist. The reaction of the urine can be followed closely enough even with litmus paper, a so-called amphoteric reaction indicating that sufficient alkali has been provided, and if the reaction does not become more alkaline than this there seems to be no danger of injuring the kidney.

Of course this method may be inadequate to cope with the more complex problems of diabetic acidosis, and it is very doubtful if the alkali can always penetrate in sufficient quantities to the seat of acid production. There is, moreover, no reason to suppose that it can influence the cause of the condition. Indeed this is rather a matter of proper feeding than a therapeutic measure. *For next to water and sodium chloride the concentration of sodium bicarbonate is the greatest in blood,* and it seems not unreasonable to care for a sufficient supply of this substance as one does for a supply of water.

There is the more reason for bearing these conclusions in mind because acidosis is one of the commonest of pathological states. Indeed I think that it is probably more common than fever. Therefore one may conclude that in serious illness the test for acidosis should always be made, especially because it is often a very simple matter to repair the defect. And I think there is some reason to suppose that such action may occasionally be of the greatest importance.

But the use of alkali must always be deliberate and founded upon the urinary reaction, for too much alkali may be very harmful indeed. As employed by Martin Fischer in nephritis, experience has convinced me that it is a source of grave danger and, if possible, graver suffering to patients who can often expect from the physician little more than some relief from pain. Yet even in nephritis there is at present no reason to avoid the proper use of alkali. In fact, I have never known a kidney to be unable to excrete a small excess of it, and I think that we may therefore always undertake the administration of soda according to the rule above laid down, with the conviction that when the quantity of sodium bicarbonate in the body is below normal, no harm is to be expected from the action of sodium bicarbonate.

Finally, if I may be permitted to express as a precept my own conclusion of the bearing of all these intricate facts upon medical practise, it is as follows. The duty of the physician is to discover that the quantity of sodium bicarbonate in the blood is diminished, to restore that quantity *to normal, and to hold it there.* But while restoring it, he must never increase the quantity above *normal.* Thus *founding* practise upon exact knowledge, upon theory fully confirmed, and upon an understanding, however imperfect, of the organization of all the manifold processes of metabolism, he may hope sometimes to block a cycle of changes leading to final disintegration, and perhaps more often to alleviate discomfort and pain.

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SCIENTIFIC EVENTS

THE IRON INDUSTRY

ABNORMAL conditions prevailed in the iron industry during the first half of 1917, mainly on account of the war in Europe. At the beginning of the year, when pig iron was being made at the average rate of about 102,000 gross tons daily, the blast furnaces were operated at slightly reduced capacity, according to E. F. Burchard, of the Geological Survey. This rate dropped to less than 95,000 tons daily in February, but in March the rate rose to 105,000 tons daily, and in April and May it stood at more than 110,000 tons, compared with the maximum rate of 113,000 tons in October, 1916.

The prospective blast-furnace capacity seems not to have kept pace with the demand, however, as is indicated by the enormous increases in price, especially since the United States entered the war.

The total output of coke and anthracite pig iron in the first five months of 1917 was about 15,800,000 gross tons, compared with about 16,175,000 tons during the corresponding period of 1916, a decrease of about 2 per cent.

The quantity of iron ore from mines in the Lake Superior region shipped from upper Lake ports from January 1 to June 1, 1917, was about 6,500,000 gross tons, compared with slightly more than 10,100,000 tons for the corresponding five months of 1916, a decrease of about 3,600,000 tons, or more than 35 per cent. This apparently large decrease in ore shipments from the principal producing region was not due to inability to mine ore but largely to the belated opening of Lake traffic because of ice blockades and to many ore-carrying boats having been put out of commission through accidents.

Plans are being made by committees of the Council of National Defense to increase shipments of iron ore, coal and coke during the remainder of the season through cooperative methods, and possibly the June shipments will nearly equal those of June, 1916. In the meantime the blast furnaces have been drawing on large stocks of ore at lower Lake ports in order to offset the deficiency in upper Lake shipments. Deferred shipments of coke and other causes of traffic congestion have also retarded operations at some furnaces.

Prices of pig iron at western Pennsylvania furnaces have advanced since January 1, 1917, 61 to 77 per cent. and since a year ago 134 to 200 per cent. On July 3, 1917, basic iron was quoted at Valley furnaces at $52 a ton, Bessemer iron at Pittsburgh at $57.95, and No. 2 foundry iron at $55, while at Birmingham, Ala., foundry iron, which one year ago sold at $14 brought $47 a ton. Low-phosphorus iron has been quoted at $70 to $80 a ton. Feverish buying of pig iron by private consumers who were endeavoring to provide for their present needs, as well as for their needs far into 1918, has caused much of the recent increase in price. The extent of the government's war needs for steel is not yet defined, but increasing. Orders are being placed slowly, however, and they should not interfere seriously with deliveries of steel to private consumers. As the government is not competing in price it would seem that there may be at least some warrant for belief that prices may eventually adjust themselves without need for further great inflation.

METEOROLOGY AND AERONAUTICAL ENGINEERING[1]

Introductory: Importance of meteorology in aviation; aircraft and weather in war: (*a*) general climate; (*b*) weather and weather forecasts: military field meteorological services.

The Atmosphere: Composition; height; "troposphere" and "stratosphere": general characteristics of each.

Temperatures in the Free Air: Vertical temperature gradients; temperatures at various heights; inversions; stable and unstable conditions in relation to flying.

Pressure: Importance; comparison with water; decrease with altitude; physiological effects of diminished pressure; measurement; mercurial and aneroid barometers and barographs: use, errors, corrections; determination of altitudes by means of barometers; isobars; pressure gradients.

The Wind in Relation to Pressure at Earth's Surface: Wind direction; deflection of winds from gradient: earth's rotation and friction; cyclonic and anticyclonic wind systems; "gradient wind;" Buys Ballot's Law; isobaric types. Wind velocity; general relation to gradient; Beaufort Scale and its equivalents in force and in velocity in miles an hour; anemometers; Robinson and Dines; gustiness of wind.

Conditions of the Atmosphere Affecting Aviation: General and Local: (*a*) general air movements, essentially horizontal; atmospheric layers and waves; (*b*) local convectional currents, essentially vertical, due to thermal controls: causes and conditions; (*c*) effects of topography upon air movements, combining both horizontal and vertical elements, due to mechanical controls: effects of friction, topography, and character of surface; vertical and horizontal movements in general in relation to flight.

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[1] Syllabus of ten lectures on Meteorology given in the course in aeronautical engineering at the Massachusetts Institute of Technology in cooperation with Harvard University, by Robert De C. Ward, professor of climatology, Harvard University.

Weather Forecasting: Explanation of daily weather map; principles of forecasting explained by reference to type maps, for United States and for Europe; general characteristics of cyclones and anticyclones; tracks; velocities of progression.

Non-Instrumental Local Forecasts. Barometric tendency; veering and backing winds; changes in wind velocity; weather proverbs.

Clouds: Types; cloud classification; methods of determining cloud heights and velocities, and results; value as weather prognostics; fair and wet weather clouds; fog, special consideration of cumulus and cumulo-nimbus.

Forecasts of Wind Velocity and Direction Aloft: Direct observation by means of pilot balloons, kites and cloud movements; directions of cloud movements in cyclonic and anticyclonic systems in the United States and in Europe; estimates based on surface conditions and on general knowledge of upper air currents; "gradient wind;" diurnal variation in wind velocity and direction; changes due to progression of cyclones and anticyclones; wind and cloud directions and night flying.

Favorable and Unfavorable Weather for Flying: Wind; clouds; haze, etc.

Laboratory Work is given at Blue Hill Observatory (10 hours) by Alexander G. McAdie, Abbott Lawrence Rotch, professor of meteorology, Harvard University, and director of the Blue Hill Meteorological Observatory, Readville, Mass.

THE DANIEL GIRAUD ELLIOT MEDAL

At a meeting of the council of the National Academy of Sciences, held June 19, 1916, the gift of Miss Margaret Henderson Elliot of $8,000 to establish a fund in memory of her father, Daniel Giraud Elliot, was accepted. This money was given to be held in trust and invested in order that there should be an income annually for a medal to be known as the Daniel Giraud Elliot Gold Medal, and an honorarium to be awarded by the National Academy of Sciences.

The conditions under which the gift is to be administered are contained in the following two paragraphs of the deed of gift:

> One such medal and diploma shall be given in each year and they, with any unexpended balance of income for the year, shall be awarded by the said National Academy of Sciences to the author of such paper, essay or other work upon some branch of zoology or paleontology published during the year as in the opinion of the persons, or a majority of the persons, hereinafter appointed to be the judges in that regard, shall be the most meritorious and worthy of honor. The medal and diploma and surplus income shall not, however, for more than two years successively, be awarded for treatises upon any one branch of either of the sciences above mentioned. Professor Henry Fairfield Osborn, of New York, the scientific director of the American Museum of Natural History in New York City and the secretary of the Smithsonian Institute at Washington for the time being, are appointed as such judges. Vacancies at any time occurring in the number of the judges shall be filled by the council of the said National Academy of Sciences, and in each case of a vacancy it is the wish of the said Margaret Henderson Elliot that the council will, if practicable, appoint to the position an American naturalist eminent in zoology or paleontology.
>
> As science is not national the medal and diploma and surplus income may be conferred upon naturalists of any country, and as men eminent in their respective lines of scientific research will act as judges, it is the wish of the said Margaret Henderson Elliot that no person acting as such judge shall be deemed on that account ineligible to receive this annual gift, and the medal, diploma and surplus income may in any year be awarded to any one of the judges, if, in the opinion of his associates, he shall, by reason of the excellence of any treatise published by him during the year, be entitled to receive them.

The council of the academy has accepted the gift and has appointed as the three judges for the bestowal of the medal and honorarium:

President Henry Fairfield Osborn, of The American Museum of Natural History.
Secretary Charles D. Walcott, of the Smithsonian

Institution of Washington.
Director Frederic A. Lucas, of The American Museum of Natural History.

The income from this gift to the academy will be sufficient to award the first medal and honorarium at the April meeting, 1918. Dr. Henry Fairfield Osborn has been designated by the president of the academy to act as chairman.

WESTERN AGRONOMIC WORKERS

The second annual meeting of western agronomic workers will be held at the Washington State Agricultural College, Pullman, Washington, and the University of Idaho, Moscow, Idaho (only nine miles apart), on July 31 and August 1 and 2, inclusive. The geographic scope of the gathering is the eleven western states occupying the territory from the Rocky Mountains to the Pacific Ocean.

The following topics will be discussed during the session:

1. Where and to what extent is it possible to eliminate summer fallow?
2. Rotation systems for irrigation sections.
3. Rotation systems for coast and intermediate sections.
4. Rotation systems for dry land.
5. Organic matter and nitrogen content of soil as affected by cropping systems.
6. Irrigation and alkali studies.
7. Methods and organization for supplying and distributing superior seed.
8. Possible extended use of new crops and the production of crops in the United States formerly supplied from other countries.
9. Cooperation among the states for investigating new problems.
10. The practical application of our investigations.
11. Better marketing, a factor for increasing food supply.
12. Collegiate courses in agronomy.

SCIENTIFIC NOTES AND NEWS

The Albert medal of the Royal Society of Arts for the current year has been awarded to Orville Wright, "in recognition of the value of the contributions of Wilbur and Orville Wright to the solution of the problem of mechanical flight." The report of the council says: "The largest share in the honor of having invented the aeroplane must always be given to the two brothers, Wilbur and Orville Wright."

M. Leclainche has been elected a member of the section of agriculture of the Paris Academy of Sciences, to succeed M. Chauveau.

Dr. William J. Mayo, of Rochester, Minn., has been summoned to Washington to confer with the government officials relative to the formation of a central medical staff in Washington, the purpose of which will be to obtain the best medical service for American soldiers while in the field.

Dewell Gann, Jr., of the medical department of the University of Arkansas, secretary of the Arkansas Academy of Sciences, has been commissioned a first lieutenant in the Officers' Reserve Corps, and expects assignment to a medical unit in France.

Mr. Barrington Moore, associate curator of woods and forestry in the American Museum of Natural History, has gone to France to give his services in a forestry regiment.

Professor Eliot Blackwelder, of the University of Illinois, is at present in California as a geological member of an advisory commission appointed by the governor of California to investigate the petroleum resources of the state.

Mr. Karl P. Schmidt, assistant in herpetology in the American Museum of Natural History, has been appointed a member of the New York State Food Commission.

The *Geographical Review* gives information concerning field work by botanists as follows: Professor F. E. Clements, who has accepted a position in the department of botanical research of the Carnegie Institution, is in the west and will devote the summer largely to grazing problems in connection with the national emergency. Incidentally he hopes to complete the task of securing material for a monograph he is planning to write on the bad lands. Dr. O. E. Jennings, of the Carnegie Museum of Pittsburgh, is spending the summer in botanical exploration and collecting along the eastern shore of Lake Nipigon, the large lake in Ontario immediately north of Lake, some sixty miles distant. Mr. Thomas H. Lake, some sixty miles distant. Mr. Thomas H. Kearney, of the Bureau of Plant Industry of the U. S. Department of Agriculture, is planning in cooperation with Dr. H. L. Shantz, of the U. S. Department of Agriculture, the studies of native vegetation as an indicator of the agricultural capabilities of land in the western states which have been in progress during the past five or six years.

PROFESSOR LAWRENCE MARTIN, of the University of Wisconsin, gave instruction in topography at the Officers Training Camp, Fort Sheridan, Ill., during the last part of June and first part of July.

DR. HUGH MCGUIGAN, professor of pharmacology in the Northwestern University, recently delivered an address on "Blood Sugar in relation to Diabetes" before the faculty and students of the graduate summer quarter in medicine of the University of Illinois.

THE first appointment to one of the new Logan fellowships at the University of Chicago has been made to Professor Walter George Sackett, of the Agricultural Experimental Station, Fort Collins, Colorado, for the academic year 1917–18. These fellowships were recently endowed by Mr. and Mrs. Frank G. Logan, of Chicago, for research in experimental medicine for the purpose of discovering new methods and means of preventing and curing disease.

THE Council of the University of Leeds has conferred upon Colonel de Burgh Birch, C.B., late professor of physiology and dean of the faculty of medicine, the title of emeritus professor.

SIR COOPER PERRY, physician at, and superintendent of, Guy's Hospital, has been elected to the office of vice-chancellor of the University of London for the year 1917–18, in succession to Sir Alfred Pearce Gould.

SIR NAPIER SHAW, director of the British Meteorological Office, has been appointed Halley lecturer for 1918, at Oxford.

THE death is announced of H. Van Laer, professor of chemistry at Mons, and president of the Chemical Society of Belgium.

UNIVERSITY AND EDUCATIONAL NEWS

AT the meeting of the board of regents of the University of Texas, held on July 12 and 13, President Vinson was continued as head of the institution, though without formal action to that effect on the part of the board. The following members of the faculty were dropped: Professors L. M. Keasbey, W. H. Mayes, W. T. Mather and A. Caswell Ellis, and the secretary of the university, John A. Lomax. Of these most had been previously mentioned as slated for dismissal by the governor, but Professor Keasbey was charged with disloyal utterances at the recent pacifist meeting in Chicago. The governor has not indicated any method by which the funds for the maintenance of the university may be secured, but the regents are making plans, on a restricted program, to have the institution open for work in the autumn.

WE learn from *Nature* that the valuable collections of Arachnida, containing more than 1,000 types, with the library, notebooks, drawings and papers in connection therewith, bequeathed by the late Rev. O. Pickard-Cambridge, to the University of Oxford, have been deposited in the University Museum and placed in the charge of the Hope professor of zoology, Professor E. B. Poulton.

J. C. BRADLEY, of Cornell University, will spend next year as assistant professor of entomology at the University of California.

FRED W. PADGETT, who for the past four years has been research fellow in oil, gas and gasoline in the University of Pittsburgh, has been appointed associate professor of chemistry in the University of Oklahoma, where he will have charge of developing a research department in oil, gas and gasoline.

HARRY CLINTON GOSSARD, assistant professor of mathematics in the University of Oklahoma, has been appointed to a mathematical position in the Naval Academy at Annapolis, Md.

Dr. Sam Farlow Trelease has been appointed assistant professor of plant physiology in the agricultural college of the University of the Philippines. He sailed on July 18 and begins his work on arriving at Los Baños.

DISCUSSION AND CORRESPONDENCE

MAN AND THE ANTHROPOIDS

In our current scientific literature one frequently meets the assertion that man is a lineal descendant of the anthropoid apes. The evident implication is that the extant anthropoids, orang, gibbon, gorilla and chimpanzee, are intended. Thus in the issue of "Science," of February 23 *ultimo*, Professor Stewart Paton remarks:

> The time is rapidly passing, as Yerkes has pointed out, when on account of the disappearance of the higher apes it will be possible to trace the various gradations in our ancestral line.

The correction of this common error lies all along the line of technical evolutionary thought from Huxley to the present, but it does not seem to have penetrated popular science. Our leading authority in this field, Professor Duckworth, in his "Morphology and Anthropology," Volume I, page 238, Second Edition, 1915, writes:

> We must conclude that the existing anthropoid apes, constituted as they now are, did not figure in the ancestral history of man.

This should relieve our anxieties regarding "our ancestral line."

While our knowledge of the anthropoids is not as complete as we might wish, the whole of it is against the supposition of the natives of the Congo and of Borneo that man is ascended from the anthropoids or the latter are descended from man. The thraldom of morphology accounts for much biological belief both ancient and modern, but the science of the present puts much more weight on anatomy and physiology. It appears to be a sound principle that groups showing inverse developments are not genetically related. Duckworth points out some of these inversions as regards man and the anthropoids, such as in dentition, in the spheno-ethmoidal angle, and in the spheno-maxillary angle. Metchnikoff, while he assumes as a hypothesis that man is descended from "some anthropoid ape," pointed out that the present anthropoids have the *os penis* which does not appear in man, and that the *hymen* which is unique to the *genus Homo* is absent in the anthropoids. Several anatomists have followed Aristotle in holding that the hand places man in a distinct order, while Topinard was equally emphatic regarding the human foot. Evidences along these lines are supplemented by pre-historic archeology, as all the older human crania are dolichocephalic, while the crania of all anthropoids are extremely brachycephalic.

Whether "scientists" are entitled to believe what they please or are to be guided by observations and verifications is perhaps an open question. Weismann accepted *generatio aequivoca,* although he admitted "all the evidence is against it." Still, many of us believe that a sound science and a sound education demand fidelity to the facts of experience and to those theories alone which grow out of them.

Mattoon M. Curtis

Cleveland

A GIRDLING OF BEAN STEMS CAUSED BY BACT. PHASEOLI

During a field trip in Michigan in July, 1914, the writer found a peculiar girdling of the stems and branches of field beans to be prevalent in several localities. Specimens were collected from Kent, Newaygo and Tuscola counties. Since then specimens of this disease have been collected from various parts of the state each year.

The disease appears at the nodes of stems and branches as small water-soaked spots. These enlarge, encircling the affected parts. Later these diseased areas become amber-colored. This girdling is usually completed by the time the pods are about half mature. The affected tissue is so weakened that from the weight of the tops the stem breaks at the diseased node. These signs of the disease may appear before any evidence of the bacterial blight upon the pods.

Inoculations into stem nodes of healthy plants, with a pure culture of *Bact. phaseoli* Erw. Sm. have produced typical signs of the disease. Plants so inoculated also showed the characteristic breaking at the stem node.

Plants inoculated in a similar manner with cultures of species of *Fusarium* and *Rhizoctonia* isolated from platings of this diseased stem tissue, showed no girdling or breaking.

It seems likely that infection results from the washing of bacteria from affected cotyledons or leaves to the axils of the leaves, but the method of entry of this organism is not yet worked out.

A more complete report upon this disease will be given at a later date.

J. H. MUNCIE
MICHIGAN AGRICULTURAL EXPERIMENT STATION

QUOTATIONS

SCIENCE AND INDUSTRY

THE important and impressive review of the rise and progress of the organic chemical industry issued by Messrs. Levinstein, Ltd., of Blackley, near Manchester, and of Ellesmere Port, which appeared as a supplement to the *Manchester Guardian* of June 30, marks a welcome development of industrial enterprise. Even the most indifferent and ill-informed reader can not but be made aware, as a result of its perusal, of the importance of the highest facilities for scientific education and training, when in so striking a fashion he is compelled to realise the fruits of it in the enormous industrial advance of Germany in all that pertains to the organic chemical industries, whether it takes the form of artificial dyestuffs, synthetic organic products, or that of chemico-therapeutics. The advent of the war quickly laid bare our serious deficiencies, not to say our utter poverty, in all three departments of chemical manufacture.

In the course of the articles, which have been written by men eminent in their respective fields of chemical science and its applications, the distinction is made absolutely clear as between industries the development of which has mainly been the result of the adoption of steam power and of mechanical appliances, and those depending upon fundamental researches of a physical and chemical character, such as are, to use the phrase of one of the writers, "built up from the depths," and require, therefore, not merely the energetic business organizer and "scientific management," with a view to output, but the highly trained scientific man capable of appreciating the discoveries of pure science and apt in their application to human needs. In this valuable review of the progress of the many departments of a vital industry—the key, indeed, to the successful prosecution of many allied and dependent industries—it is clearly revealed how remiss the nation has been in a true appreciation of what constitutes the firm foundation of industrial preeminence. The fault has lain not so much, as some of the writers seem to indicate, with the colleges and universities as with the industries concerned, which have hitherto offered small salaries and poor prospects to the carefully trained and competent science student; indeed, have looked upon the chemist as a necessary evil, to be avoided if possible.

One of the most important articles is that by Dr. Levinstein, inasmuch as he carefully points out the respective spheres of the university and the works in the effective training of the future industrial chemist. Once those concerned with the successful administration of our industries realise the necessity for encouraging by a liberal payment the work of the efficiently trained chemist there will be no lack in the supply of suitable men. That the nation contains such men has been shown by the fact that the demands of this devastating war for the supply of high explosives have been met with an energy and an efficiency which have surprised our chief enemy.—*Nature*.

SCIENTIFIC BOOKS

The Theory of Measurements. By LUCIUS TUTTLE, B.A., M.D., Philadelphia, Dr. Lucius Tuttle, Jefferson Medical College. 1916. Pp. xiv + 303. Price $1.25.

Any one who has read the reports on elementary laboratory work in physics presented by average students must have been impressed frequently by the writer's lack of familiarity with ordinary methods of computation and by his inability to draw rational conclusions regarding the accuracy and significance of his results. Unfortunately, the instruction in these matters presented by many widely used laboratory manuals is very inadequate and frequently misleading. We all admit that the primary object of elementary laboratory work is to put the student in personal touch with the facts and principles of physical science. But every experienced teacher knows that this object is not attainable without more or less formal instruction in the methods of reduction and interpretation of observations. Moreover, the student is seriously handicapped by the long-hand arithmetical processes taught in secondary schools when greater precision and facility can be attained by the shortened methods of computation adopted by every competent physicist.

A number of books designed to fill this gap by a detailed discussion of methods of computation and the theory of errors have appeared during the past few years. Dr. Tuttle's "Theory of Measurements" belongs in this group and it meets the needs of students in elementary physics more adequately than any other text that has come to the reviewer's attention. For the most part, concrete examples are developed to illustrate general principles and the discussions are so clear and well stated that the student can hardly fail to grasp their significance. The treatment presupposes no training in mathematics beyond that usually required for admission to college. In fact capable high-school pupils should find little difficulty in following the discussions.

The most important topics treated in the first one hundred pages of the book are as follows: fundamental ideas, abridged methods of multiplication and division, units and measurements, angles and circular functions, accuracy and the correct use of significant figures, logarithms, computations involving small magnitudes, and the use of the slide rule. The reviewer would be inclined to place more emphasis on the importance of systematic orderliness in computation and exact specification of units in writing numerical results. But on the whole the treatment is very good and guards against most of the common errors of inexperienced computers.

About seventy pages are devoted to a very illuminating discussion of the methods of graphical representation and reduction of observations, including a brief treatment of interpolation and extrapolation. The possibility of emphasizing the significance of the plotted data by a suitable choice of scales is illustrated by numerical examples and the advantages of so choosing the variables that the graph will be linear are pointed out. The uses of logarithmic and semi-logarithmic papers are also illustrated.

The remaining portion of the book deals with errors of observation and measurement, statistical methods, the determination of the best representative value from a series of discordant observations, the estimation of the precision of direct and indirect measurements, and simple applications of the method of least squares. The formulæ of the theory of errors are not derived mathematically but their significance and use are very clearly explained and illustrated by numerical examples.

The book is neatly printed and substantially bound. It should find a place in every physical laboratory devoted to the instruction of students.

A. DeForest Palmer

SPECIAL ARTICLES

LITHOLOGIC EVIDENCE OF CLIMATIC PULSATIONS

The geologic evidences of changes of climate, as is well known, are numerous and incontrovertible, particularly as regards extremes of temperature and their accompanying variations of flora and fauna. The climatic changes which have produced the most widespread changes in life forms, as well as physiographic features, have been the ones most clearly recognized and easily studied. These changes are known to have been pulsatory or periodic, but with periods or cycles enduring for possibly many thousands of years.

In modern times, and in very recent geologic times as well, there have been minor fluctuations or pulsations in climate in various parts of the earth, as ably demonstrated by Brückner, Huntington and others. The "Brückner cycle," about thirty-five years in length, illustrates one type of pulsation. Hann, Melldrum, Douglass, and others have observed an eleven-year period to be about the average length of time between the maxima of wet or dry conditions. While the length of the cycles or periods may vary, the combinations of these shorter cycles of climatic changes are considered as making up the grand or climatic cycles, which are the ones best known in geology.

If the pulsatory theory of climatic change is a true interpretation of the observed facts of recent times, as seems very probable, then one may naturally inquire if similar pulsations or minor changes in climate have not occurred in the geologic past. If they have, what evidence, if any, is to be found in the rocks? The work of Barrell, Sayles, Case and others, in their studies of sedimentation, seems to definitely correlate climatic fluctuations with various phases of erosion and deposition. It may be of interest to submit some facts which may prove to be additional evidence of climatic pulsations, as afforded by certain "sedimentary" rocks.

The writer, in the course of a study of the sandstone formations in the foothills southwest of Fort Collins, in northern Colorado, came to the conclusion that much of this sandstone is of subaerial, and not subaqueous, origin. The sandstones of this region are commonly referred to as "Red Beds." The stratigraphic names are the Lyons, and the Lykins formations.

In the most prominent ridge of the Lykins outcrop are located a number of quarries from which flagging and building stone have been taken for many years. One prominent feature of much of this stone is its variegated laminations. These are usually alternate layers of white and brown sands, although other colors are occasionally found. These layers vary in thickness from about 0.5 mm. to 30 or 40 mm. In a number of cases the white layers are much thicker than the brown, while in many other cases the two kinds of layers are nearly equal in thickness. Also, the brown layers are often thicker than the white. Very thin alternate layers often occur, and there are usually many of these in a group when they do occur.

Examination of the character of typical samples from these layers shows, essentially, the following facts:

1 The white layers are composed almost wholly of very well rounded grains of white quartz, with scattered specks of iron oxide; the quartz grains are nearly uniform in size, the largest being rarely over 1 mm. in diameter, and the smallest about 0.3 mm. in diameter; the white layers are almost wholly free of any colored cement, and of angular or even subangular grains; many of the grains are pitted; wind ripples are frequently found at the top of a white layer, on exposed bedding planes.

2. The brown layers are composed almost wholly of angular and subangular grains of many different sizes, from very small to over 1 mm. in diameter; comparatively few rounded grains are present; the color is due to a coating of iron oxide on most of the grains.

These differently colored layers of sand, having such markedly different characteristics, would seem to point clearly to rather different origins. The factors and forces contributing to their formation can hardly be said to be identical. The material of the white layers suggests rounding, pitting, sorting, and deposition by the wind. The material of the brown layers has evidently been water-worn and water-borne, coming from a comparatively distant region. The occurrence of these different layers with their implied differences in origin and deposition may well suggest something of the history of this region, especially in regard to the extent and frequency of rainfall.

As these rocks contain no fossils, and in their general lithological character point to deposition by the wind, one may at least tentatively conclude that the climate of this region was rather arid at the time the sands composing these rocks were put in place by the forces of nature. This part of the continent was evidently a portion of the great inland desert which is thought to have existed in Triassic times.

It seems probable that at one season this particular locality was swept by winds carrying a burden of well-worn quartz grains, which was dropped when the force of the wind was checked. When the wind rose again, some of this sand was doubtless moved farther on, but a little remained to add to the accumulating layers beneath. At another season, the surface of this wind-laid sand was covered by a deposit of entirely different material, probably brought from some neighboring zone of alluviation by torrential rains. When the water had flowed on, or evaporated, the red-brown material became exposed to the winds, part of it was doubtless swept away, but some was covered with desert sand which continued to accumulate until the next freshet sent more of the red-brown sediment into the depression in the zone of dunes. That this was approximately the mode of deposition seems likely, when we find the one layer to be characteristically wind-borne, and the other water-borne, when all the accompanying facts are considered, and comparison is made with sand deposits that are being formed at the present time.

The study of this sandstone takes on an added interest if we note further that the frequency of recurrence of the brown or white layers often shows a striking regularity or periodicity. Where we find fairly broad white bands, with very thin brown layers alternating, it would seem that a relatively dry season is indicated. On the other hand, when the brown layers are very numerous and close together, it apparently points to frequent rains, with comparatively little deposition of the white sands by the wind. In the solid rock wall, as observed in the quarries, one can note the more or less regular recurrence of the wider bands of white, and if one could be sure that here a wide white band and one or more narrow brown bands represented the deposit of an arid year, one could determine the time required to produce a given thickness of this rock and also draw some conclusion as to the relative aridity of a given year or a series of years. But one can not at present state, beyond reasonable limits, the amounts of either kind of material that might be deposited in a year, and therefore one may not yet say definitely how long it took for a given stratum to be formed, or whether the aridity indicated by a white band corresponds to one season or to several. It may be interesting to note, however, that the recurrence of groups of brown layers with a

White Layer	Thickness of White Layers, in Mm, Bottom to Top								
	Section I.					Section II.			
Fifteenth........		*22*							
Fourteenth......		2			*14* (top)				
Thirteenth......		5			13				
Twelfth...........		5			12				
Eleventh.......		17	*15*		8				
Tenth		7	8		9				
Ninth...........		4	6	*22*	8	*32*			
Eighth...........		10	8	15	7	25			
Seventh	*15*	8	4	7	8	28	*22*		
Sixth.......	10	8	11	15	10	20	22	*15*	
Fifth...............	5	10	8	17	10	15	15	15	
Fourth...	5	11	12	7	8	18	20	18	
Third.	5	10	16	5	5	20	16	21	6 (top)
Second..........	10	8	4	6	7	25	18	15	12
First.......	*15*(*B*)	(*15*)	(*28*)	(*15*)	(*22*)	*25*(*B*)	(*32*)	(*22*)	(*15*)

corresponding decrease in thickness of the white layers is found, on the average, following every tenth or eleventh layer.

This recurrence, as observed at a number of places on the quarry walls, as well as on detached fragments, ranges from the sixth to the fifteenth white layer. For example, at one place (Quarry "*A*," Section I.) the writer measured the thickness of the series of white layers, the thickest layers recurring as follows: seventh, eleventh (from and including the seventh), fifth (or fifteenth from the seventh), eleventh, ninth, fourteenth. At Section II., Quarry "*A*," the thickest white layers recur as follows: ninth, seventh, sixth. At another place (Quarry "*B*"), about a quarter of a mile away, the following periods were observed: tenth, twelfth, tenth, seventh, eleventh, fifteenth, tenth, twelfth, sixth, thirteenth, sixth. These three sections are about 2.5, 2 and 4 feet in thickness, respectively. The details of these measurements are shown in the tables above. On about 18 quarried fragments it was found that on the average every eighth to twelfth white layer was thicker than those between. On several such fragments, this recurrence was observed as follows: eleventh; tenth; eleventh and following ninth; eighth; ninth and following eleventh; tenth.

Another striking periodicity may be noticed in the tables. These periods correspond rather well to the average number of years in the Brückner cycle, as from the top of column 1, Section I., Quarry "*A*," to the top of column 4, same section, there are a total of 33 white layers. In the section from Quarry "*B*," from the layer at the top of column 4 to the top of column 7, there are 34 white layers; from the top of column 7 to the top of column 11, there are 34 white layers. Likewise, from the top of column 2 to the top of column 6 there are 40 white layers; from the top of column 6 to the top of column 10 there are 38 white layers.

It may be that it is just by chance that these layers are arranged in this way, yet the agreement with known climatic pulsations is so striking as to make one ask whether it is just chance after all, or a result of natural laws. It is quite evident that the recurrence of layers of a certain character is periodic. Whether one can in this manner safely assign a limit to the yearly deposits seems questionable, but one may certainly inquire into the probability of deducing from a study of these variegated sandstones the conclusion that at the time of their formation the climatic conditions, especially with reference to rainfall, were fluctuating much as they have been within recent times.

It would be distinctly interesting to know whether geologists can find, in more exact and complete studies, further evidence of pulsatory changes of climate having been recorded in the clastic rocks.

C. E. VAIL

COLORADO AGRICULTURAL COLLEGE,
FORT COLLINS

Quarry "B," Section I

White Layer	Thickness of White Layers, in Mm., Bottom to Top										
Fifteenth						*11*					
Fourteenth						3					
Thirteenth						2				*10*	
Twelfth		*15*				9		*11*		4	
Eleventh		5			*15*	5		7		7	
Tenth	*6*	6	*13*		4	5	*14*	9		6	
Ninth	3	3	6		5	6	8	10		5	
Eighth	5	8	4		10	8	10	10		5	
Seventh	4	2	10	*16*	10	5	7	8		7	6 (top)
Sixth	4	2	9	15	10	8	3	6	*20*	7	*13*
Fifth	5	5	10	18	4	4	9	10	6	5	12
Fourth	7	4	6	5	2	15	12	11	5	7	10
Third	6	4	4	10	3	15	10	6	5	6	10
Second	6	5	3	3	5	10	5	7	8	13	8
First	*10*(B)	(*6*)	(*15*)	(*13*)	(*15*)	(*15*)	(*11*)	(*14*)	(*11*)	(*20*)	(*10*)

KANSAS CITY MEETING OF THE AMERICAN CHEMICAL SOCIETY

THE fifty-fourth meeting of the American Chemical Society was held at Hotel Muehleback, Kansas City, Kansas, from April 10 to April 14, 1917. The general program was carried out under the able leadership of Professor Julius Stieglitz, president of the society, and Dr. Charles L. Parsons, secretary, while the various divisions were presided over by Charles L. Alsberg, E. H. S. Bailey, J. E. Breckinridge, J. R. Bailey, H. E. Howe, H. P. Talbot, L. F. Kebler and T. J. Bryan.

During the session the usual order of business was carried out, consisting of meetings of the council, inspection of plants, with general and public sessions. A complimentary smoker and subscription banquet added to the diversion of the week.

On Wednesday morning, April 11, addresses of welcome were given by Hon. George H. Edwards, mayor of Kansas City, and by Dr. Frank Strong, chancellor of the University of Kansas. Response to these addresses was made by President Julius Stieglitz. Mr. Arthur J. Boynton gave a very interesting paper on the Economic resources of the Kansas City zone.

Wednesday afternoon was given over to a public session, of which the program was as follows:

PETROLEUM AND NATURAL GAS

H. P. Cady, *Chairman*

The geology of the mid-continent oil and gas fields: RAYMOND C. MOORE.

Variations in the composition of gases of the mid-continent field: H. C. ALLEN and E. E. LYDER.

Helium and associated elements in Kansas natural gases: C. W. SEIBEL.

Some experiences in the use of oxy-acetylene welding in long distance natural gas transportation: E. P. FISHER.

The cracking of petroleum in the liquid phase: ROY CROSS.

One billion gallons of synthetic gasolene in 1918: WALTER F. RITTMAN.

The chemical work of the petroleum division of the Bureau of Mines: HARRY H. HILL.

Thursday morning was given over to a symposium on the chemistry and metallurgy of zinc, Professor John Johnson presiding. The remainder of the day and Friday were occupied with the meetings of the divisions.

The following abstracts of papers presented have been prepared by the authors for publication in SCIENCE:

DIVISION OF BIOLOGICAL CHEMISTRY

C. L. Alsberg, *Chairman*

I. K. Phelps, *Secretary*

The toxicity of galactose and mannose for green plants and the antagonistic action of other sugars toward these: LEWIS KNUDSON. The toxicity of galactose to the growth of *Pisum arvense* L. and to *Triticum sativum* L. was inhibited by glucose or saccharose, the former being slightly more effective than the latter. But levulose, arabinose, maltose and raffinose do not inhibit the toxicity of galactose, although in presence of levulose the primary root may continue its growth to a limited extent It was found that 0.0125 mol. galactose was as toxic as 0.025 mol, the other sugars being used at a concentration of 0.025. Mannose had a toxic effect similar to galactose. Glucose or saccharose inhibited the toxicity of mannose.

The effect of three annual applications of boron on wheat: F. C. COOK and J. B. WILSON. Borax and colemanite were applied to horse manure in amounts sufficient to act as a fly larvicide. The manure was applied to the same plats at the rate of 20 tons per acre for three consecutive years and wheat was grown on the plats each year at Arlington, Va. A borax, a colemanite, a manured control and an unmanured control plat were used. It is calculated that the upper 6 inches of soil of the borax plat received .0088 per cent. H_3BO_3 the first year and .0022 per cent. the second and third years. The colemanite plat likewise received .0029 per cent. H_3BO_3. Borax reduced the yield of grain 10 per cent. in 1914 and 1915, colemanite had little effect. In 1916 the yields from all four plats were low, but the borax plat gave the largest yield. The only apparent injury to the wheat was the first season on the plat receiving the large amount of borax. There were no evidences of any cumulative action of boron in the soil.

The after-ripening of fruits: F. W. MUNCIE and W. P. JAMES, Illinois Agricultural Experiment Station, Department of Horticulture. Attempts to preserve peaches by encasing with hard paraffin were unsuccessful, since considerable decomposition resulted after two months, with a marked production of alcohol and an intensely bitter taste. The color, however, remained normal, and the skeleton of the fruit was not broken down. This last condition is similar to that described for other fruits kept in an atmosphere of CO_2 by other workers and is apparently due to an accumulation of carbon dioxide within and about the fruit.

Peaches decomposed rapidly about the spot where an injection of invertase had been made, or in a solution of invertase. Similar experiments are in progress with apples, in an effort to explain the discrepancy between the decrease in sucrose content of apples during ripening found by Bigelow, Gore and Howard and the absence of invertase from the apples studied by Thatcher. Flesh and epidermis of peaches kept in an atmosphere of O_2 for two months became golden yellow, but turned brown quickly on exposure to air. The flesh was soft, contained a little alcohol, and had an insipid taste. Quantitative study of the respiration of apples in an atmosphere of oxygen, showed that the rate is higher under this condition than in an atmosphere of air.

Quantitative determination of carbohydrates in plant tissues: F. W. MUNCIE and D. T. ENGLIS. If fresh plant tissue is plunged into warm alcohol and after standing two weeks, the alcohol removed by decantation and expression before extraction with hot alcohol, a large percentage of the sugar (96 per cent. in one experiment) is removed and loss of fructose by hot extraction largely avoided. Mercuric nitrate is more satisfactory to use than the acetate and 10 per cent. phosphotungstic acid than the more concentrated solution used by them. Asparagin also is quantitatively removed from solution by mercuric nitrate provided the solution is made just alkaline to litmus with sodium hydroxide or carbonate after addition of the mercuric salt, then just acid with a few drops of weak acid. No mercuric oxide is precipitated by such a procedure. These reagents, especially the phosphotungstic acid, invert sucrose so quickly that they are not applicable to the determination of a mixture of sucrose, glucose and fructose, excepting when sucrose has been previously determined. This may be done by using basic lead acetate as the clearing agent, by the polarimetric method if the inversion is made with invertase or solution again made neutral after use of acid. When the value for sucrose is known, the original solution partially cleared with SO_4-free alumina cream is inverted with invertase, then nitrogenous impurities removed with mercuric nitrate and phosphotungstic acid and total glucose and fructose determined. Subtraction of value for sucrose leaves the values for glucose and fructose present in the original solution.

A physical and chemical study of the kafir kernel: GEORGE L. BIDWELL. Dwarf, black-hulled, white kafir kernels were separated by hand into bran, germ and endosperm. These parts were analyzed and compared to corresponding parts of corn and were found to resemble them closely. In the bran a wax-like substance was found. The ether extract of the germ was found to be liquid. The endosperm yielded an ether extract not yet examined. The coloring matter in this sample does not seem to be associated with tannin. The endosperm may be separated into starchy and horny parts, the former having less protein than the latter.

Oil from the avocado: H. S. BAILEY and L. B. BURNETT. The production of the avocado or alligator pear in the United States is increasing so rapidly that there is a possibility of large quantities of this fruit being available as a source of oil. The fruit when fully ripe contains approximately 80 per cent. of moisture and the dried material about 50 per cent. of oil. So far no method has been found by which the oil can be extracted from the fruit in a sweet, edible condition, and as the oil when extracted with ether and the solvent removed at low temperature in vacuum has a bitter taste, it is very doubtful whether the oil as it exists in the fresh fruit itself is palatable if separated from the accompanying pulp. By means of the usual hydrogenation process it is comparatively easy to convert either the expressed oil or that extracted by solvents into a solid, white, tasteless, fat which resembles in its physical properties ordinary hydrogenated cottonseed oil.

Oil from the Stillingia sebefera: H. S. BAILEY and L. B. BURNETT. The fruit of the semi-tropical tree *Stillingia sebefera*, which grows in China and has been introduced into some of the southern states of this country, produces two glycerides. The exterior of the seed is covered with a wax-like substance from which is derived the Chinese vegetable tallow of commerce. The interior of the seed contains an oil usually known as stillingia oil. Certain statements in the literature indicate that this oil even in China is not used for food purposes and probably has poisonous properties. The constants of these oils have been determined, and experiments made by Dr. William Salant, of the Bureau of Chemistry, in feeding rabbits with both the expressed and extracted oils. So far as the results obtained with the small amount of material available are conclusive, it appears that stillingia oil is not toxic and has practically the same effect as other vegetable oils.

A noteworthy effect of bromides upon the action of malt amylase: ARTHUR W. THOMAS. The action of sodium and potassium bromide upon malt amylase was found to be inhibitory when present in small amounts, but when these salts were present in greater concentration an activating action was obtained. This action was found when highly purified Lintner soluble starch and thrice repurified bromides were used.

Availability of the energy of food for growth: C. ROBERT MOULTON, Missouri Agricultural Experiment Station. Three beef steers were subjected to digestion trials and maintenance trials. One was slaughtered as a check. The other two were fattened, one to full prime condition and the other to forty or fifty days under prime. All were analyzed. From the analysis the composition of the animals was determined and the composition of the gain. From the feed records and analyses the nutrients consumed above maintenance were determined. The energy equivalent of the flesh gained and of the feed consumed above maintenance was calculated. The two fattened steers saved in flesh gained 53.39 and 52 49 per cent. of the metabolizable energy consumed above maintenance. For similar conditions and a similar ration Armsby shows about 55 per cent availability. This is an experimental verification of his calorimetric work.

Investigation of the Kjeldahl method for determining nitrogen; the influence of reagents and apparatus on accuracy: I. K. PHELPS and H. W. DAUDT. As a result of many experiments the conclusion was reached that in all routine work involving determinations by the Kjeldahl method it is necessary to deduct from the result obtained the amount corresponding to the nitrogen contributed by reagents and apparatus in use in the particular experiments. It is obvious that under less carefully controlled conditions in routine work the errors, which are here called inappreciable, will become large enough to seriously effect the accuracy of the results obtained.

A study of the estimation of fat in condensed milk and milk powder: C. H. BIESTERFELD and O. L. EVENSON. The Roese-Gottlieb method as applied to condensed milk and milk powder gives low results, the average error in the case of condensed milk being 0.04 per cent. The residual fat is obtained by treating the liquid left after three extractions by the Roese-Gottlieb procedure with acetic acid, heating and reextracting with ethyl and petroleum ethers. A method also is described which permits the recovery and repeated use of the solvents.

The Schneyer method for the determination of lactic acid in urine: MARY E. MAVER. The Schneyer method for the quantitative determination of lactic acid in urine is not applicable, particularly under pathological conditions. The method is based on the production of CO when the ether extract of urine is treated with H_2SO_4. Hippuric acid is present in the ether extract and does yield CO. Other substances yielding CO, such as oxalic and citric acid, do not enter the ether extract by this method. Citric acid is present in normal urine. The method is of unquestionable value in indicating the excretion of substances under pathological conditions which belong to a group of substances capable of yielding CO under the conditions of the experiment.

On the optimum reaction for tryptic proteolysis: J. H. LONG and MARY HULL. It has generally been assumed that tryptic digestion is possible in a neutral or slightly alkaline medium only, but some recent investigations suggest that these limits are too narrow. Employing fibrin as a substrate, the authors have found the optimum point at a hydrogen ion concentration between 10^{-8} and 5×10^{-9}, which is in agreement with the results of Michaelis and Davidsohn for a fibrin peptone substrate. The authors have found, however, that for casein as a substrate the optimum point is distinctly higher, and within the limits 3×10^{-6} and 5×10^{-7}. It is probable that for each type of protein there is a distinct range for the optimum activity and that casein may not be the only protein which is changed readily on the acid side of neutrality. Investigations on other proteins are in progress.

On the normal reaction of the intestinal tract: J. H. LONG and FREDERICK FENGER. Employing the electrometric method of estimation the authors have studied the reaction of the small intestines of a number of animals and also of man. Misled by the false interpretation of the results of indicator tests certain writers have reached wrong conclusions regarding the normal or usual reaction between the pylorus and the lower end of the ileum. In the case of animals the whole intestine has been removed immediately after death, tied into three loops and each loop investigated separately. In some cases the reaction has been found to be acid throughout and from 1 to 8×10^{-7}. Alkaline reaction seems to be less common than acid, and far from the strength once assumed for the duodenum with its alkaline "zone." In the human subject material has been secured from points well below the duodenum by aid of Rehfuss tubes. An acid reaction is frequently noted here and persisting more frequently than the temporary alkalinity following the entrance of bile and the pancreatic fluids

Studies of the gastric residuum. No. III. The relation of total phosphorus to acidity: **CHESTER C. FOWLER**, Iowa State College. In view of recent support of a modification of Maley's hypothesis concerning gastric hydrochloric acid formation and a suggestion of approximate proportionality which might be expected to occur between the acidity of the juice and its acid calcium phosphate, it seemed desirable to study phosphorus and phosphorus partition of the gastric residuum. Thus fifty-two samples from apparently normal women were obtained and individually analyzed for total phosphorus. The conclusions follow: (1) Total phosphorus was not proportional to total or free acidity. (2) The minimum P_2O_5 content was 6.48 mgr per 100 c.c. and the maximum was 30.03 mgr. (3) About 58 per cent. of the samples fell within the range P_2O_5 equivalent to 12–18 mgr., while about 21 per cent. lie above and 21 per cent. below these values. (4) A tendency toward a constant P_2O_5 content was shown in individuals who were examined more than once. (5) The average P_2O_5 content was 15.66 mgr. In a previous investigation made upon a composite residuum sample obtained from seventy men, a value of 12.16 mgr of P_2O_5 per 100 c.c. of residuum was obtained.

The utilization of carbohydrate on a relatively high and low cereal diet: **ZELMA ZENTMIRE** and **CHESTER C. FOWLER**. The object of the study was to determine any differences in the utilization of cereal protein and carbohydrate in thoroughly cooked cream of wheat when ingested in varying amounts. The data on protein utilization will be presented in a later paper. The experiment was divided into two periods of five days each with relatively high and low amounts of cereal in the diet; and two periods of two days each of nitrogen-free diet of relatively low and high starch content. Casein and milk were added to the cereal diets and butter fat and sucrose to all diets. Foods and feces were weighed and analyzed. The *total* carbohydrate utilization for each of the four periods was over 99 per cent. If the utilization of sucrose and milk sugar is taken as 100 per cent., the utilization of the starch and cereal carbohydrate is about 98 per cent.

The nature of the inosite phosphoric acids of some important feeding materials: J. B. **RATHER**, Arkansas Agricultural Experiment Station. An inosite phosphoric acid has been separated from wheat bran corresponding in composition to the formula $C_{12}H_{41}O_{42}P_9$, the formula previously proposed for this substance by the writer. It corresponds equally as well to the formula

$$C_6H_6(OH)(H_2PO_4)_5,$$

inosite pentaphosphoric acid. The latter formula, almost exactly one half of the first formula, and that of a theoretically possible compound is adopted as the more desirable. The principal inosite phosphoric acid of a sample of corn was found to be inosite pentaphosphoric acid, and neither inosite hexaphosphoric acid, nor the acid $C_2H_8P_2O_9$. The principal organic phosphoric acid of a sample of kafir corn was found to be inosite pentaphosphoric acid.

The formation of ester hydrolyzing substances by the action of alkali on casein: **FLORENCE HULTON FRANKEL**. Harriman Research Laboratory, Roosevelt Hospital, New York. The action of alkali on casein causes the formation of ester hydrolyzing substances, the formation of which is practically independent of the concentration of alkali, time of standing and temperature of standing. The substance is more active in very slightly alkaline solution (10^{-8}–10^{-10}) and loses a part of its activity on boiling. It can be entirely removed by long dialyzing. The action was tried on various esters.

Factors influencing the proteolytic activity of papain: **EDWARD M. FRANKEL**. Papain may be purified by precipitation from aqueous solution with acetone or ethyl alcohol. The ferment is inactivated by acids and alkalis in concentrations from 0.02 normal upwards. The enzyme is active between hydrogen ion concentrations 10^{-2} and 10^{-9}, the optimum being at 10^{-5}, calorimetric standards being used throughout. The quantitative relations of the enzyme and substrate have a marked effect on the extent of proteolysis, increasing quantities of either component causing an increase up to a certain point after which further additions have little effect. In the presence of HCN the proteolytic activity of papain is largely increased the same general relations between enzyme and substrate holding. Increasing the amount of HCN causes increased proteolysis up to a certain point, after which further addition caused no marked change. The same hydrogen ion optimum holds for papain in the presence of HCN as in its absence. HCN will cause further proteolysis in enzyme substrate mixtures that are apparently in equilibrium.

Variations in the chemical composition of alfalfa at different stages of growth: **H. S. GRINDLEY** and **H. C. ECKSTEIN**. In connection with investigations which the Illinois Experiment Station is making to determine the value of forage crops for the growth of farm animals, it became necessary to make complete chemical analyses of young growing grasses and legumes. The first young forage crop to study was that of alfalfa. The work includes the determination of the approximate composition, the forms of non-protein nitrogen, and the forms of protein nitrogen in the grasses and legumes. The results so far obtained with alfalfa lead in general to the following conclusions: First, that young alfalfa is very rich in crude protein; second, that as alfalfa grows older, there is a marked increase in the percentage of nitrogen free extract and crude fiber and a marked decrease in the crude protein of the water-free substance of the plant; third, it seems probable that the marked efficiency of young growing pasture grasses is due (*a*) to their high content of crude protein (*b*) to their high content of mineral constituents and (*c*) to the low content of crude fiber.

Physical and chemical constants of some American tomato seed oils: H. S. Bailey and L. B. Burnett. A number of tomato-seed oils have been made from seeds collected at various tomato pulp factories in Indiana and Maryland and the physical and chemical constants of these oils and their fatty acids determined. One point of particular interest in connection with the tomato-seed oil is that it gives a positive test for peanut oil by the Renard test. If sufficient care, however, is taken in determining the melting point of the final crystalline acids it will be found that they are higher than 72° C., which is usually accepted as the proper temperature for arachidic acid obtained in this method. The analysis of the methyl esters of tomato seed oil and of the saturated fatty acids obtained by the lead-salt-ether method from tomato-seed oil have been made.

A laboratory method for the hydrogenation of oils: L. B. Burnett and H. S. Bailey. A method of preparing a nickel catalyzer, suitable for the hardening of vegetable oils on a small scale in the laboratory, was described.

Electrically heated melting point apparatus: H. S. Bailey. A form of melting point apparatus heated by the passage of an electric current through a bath of dilute sulphuric acid, was described. The resistance of the solution to the passage of the current produces the heat, the increase in which may be regulated by adjustment of the distance between the poles.

The alkaloids of Bocconia frutescens: Emerson R. Miller. In 1895 Battandier examined the bark of *Bocconia frutescens* and reported the presence of fumarine (protopine), bocconine, chelerythrine and traces of an alkaloid giving reactions similar to those of chelidonine. Bocconine, according to Schlotterbeck, is identical with β-homochelidonine. The writer separated from the leaves of the above-named plant protopine, chelerythrine, β-homochelidonine and γ-homochelidonine. The indications are that the bark contains sanguinarine in addition to the alkaloids reported by Battandier.

On the presence of free hydrocyanic acid in cassava: Emerson R. Miller. Some experiments carried out by the writer while connected with the Cuban Experiment Station show that most of the hydrocyanic acid contained in the roots of *Manihot utilissima* is present, combined as a cyanogenetic glucoside.

The effect of feeding acids upon the growth of swine: A. R. Lamb and John M. Evvard. Although the power to use ammonia produced in the body tissues for the neutralization of acids is known to be possessed by animals, the practical question of the effect of acid-feeding upon growth has not been investigated. Inasmuch as silage contains organic acids in considerable amount and the mineral content of many feeding-stuffs is strongly acid in character, this question is important. Eight pigs, divided into 4 lots, were grown successfully from 85 to 260 pounds weight in seven months upon a normal ration to which considerable amounts of lactic, acetic and sulphuric acids were added.

Can swelling of the colloids furnish a basis for the explanation of edema? A. D. Hirschfelder. Edema due to mustard oil in the conjunctival tissues, the effects of immersing the lid in blood serum, hydrochloric acid, etc., effects of local and general changes in blood pressure upon the development of edema, were discussed.

The following papers were read by title:

The proteins of the peanut, Arachis hypogea. II. The distribution of the basic nitrogen in the globulins arachin and conarachin.

Tissue transplantation as a biochemical method: Leo Loeb.

The alkaloids of Bocconia frutescens: Emerson R. Miller.

Microchemical studies on the mosaic disease of tobacco: G. W. Freiberg.

Some peculiarities of plant decoctions as nutrient media for fungi: B. M. Duggar.

Isolation of parahydroxy-benzoic acid from soil: E. H. Walters.

(*To be continued*)

SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE WORK OF THE NATIONAL RESEARCH COUNCIL

As has already been announced, the National Research Council is acting as a department of the Council of National Defense, dealing with the organization of science and research as affected by the war.

Direct connection with the work of the Army and Navy, both at home and in the field, has also been established. Brigadier General George O. Squier, chief signal officer, has recently addressed the following letter to the chairman of the Research Council:

Dr. George E. Hale,
Chairman, National Research Council,
Munsey Building,
Washington, D. C.

My dear Dr. Hale: In the Signal Corps questions involving the selection and organization of large numbers of scientific men and the solution of research problems are constantly arising. The National Research Council, organized at the request of the President, and acting as a department of the Council of National Defense, in close cooperation with similar bodies abroad, has federated and coordinated the scientific resources of the country and concentrated them upon the solution of military problems. It is accordingly the one agency in a position to meet the present needs of the Signal Corps.

I therefore request the Research Council to act as the advisory agent of the Signal Corps in the organization of its various scientific services and the solution of research problems. To this end I would suggest that Dr. Robert A. Millikan, vice-chairman and executive officer of the Research Council, apply for a major's commission in the Officers' Reserve Corps, for detail in charge of this work.

Very truly yours,

George O. Squier,
Brigadier General,
C. S. O.

July 2, 1917

In accordance with this request Dr. Millikan is now acting as the representative of the National Research Council in general charge of scientific questions referred to the council. Dr. C. E. Mendenhall has been put in charge of the development of the various instruments used in connection with airplanes. Dr. Augustus Trowbridge, also nominated by the council, has organized an important branch of the scientific service for the army in France. Other scientific services for the army are in process of organization.

The Navy Department has recently established a special board of four naval officers and four civilian advisory members to coordinate and organize all problems relating to submarine warfare. The National Research Council is officially represented on this board by its executive officers. The general plan adopted by the Navy Department contemplates the closest possible cooperation between the Navy Department bureaus, Navy Department boards, the Naval Consulting Board, and the National Research Council. A group of forty leading physicists, convened by the National Research Council for an exhaustive discussion of submarine problems with the members of the French Scientific Mission, is now represented by a committee cooperating with the above mentioned special board in tests and investigations of various devices for submarine offense and defense. Many physical laboratories are also taking part in this work.

The chairman of the council, Dr. George E. Hale, has given his entire time to the work in Washington, and the following members of the council are residing there as well:

Dr. Raymond Pearl, chairman of the agricultural committee.
Dr. William H. Holmes, chairman of the anthropology committee.
Dr. S. W. Stratton, chairman of the committee on census of research.
Dr. M. T. Bogert, chairman of the chemistry committee.
Dr. W. F. Durand, chairman of the aeronautics committee, and vice-chairman of the engineering committee.
Dr. Alonzo E. Taylor, chairman of the food committee.
Dr. V. C. Vaughan, chairman of the committee on medicine and hygiene.
Dr. Charles D. Walcott, chairman of the military committee.
Dr. L. A. Bauer, chairman of the committee on navigation and nautical instruments.
Dr. Van H. Manning, chairman of the committee on noxious gases.
Dr. R. A. Millikan, chairman of the physics committee.
Dr. C E. Mendenhall, vice-chairman of the physics committee.

During the past month the above-mentioned members of the council have been actively cooperating with the members of the French scientific mission now in Washington, as a result of which it has been possible to formulate various agencies for the consideration of technical problems for the solution of which definite need has arisen at the battle front. The members of this mission have recently been joined by Dr. Giorgio Abetti of the Royal Astronomical Observatory of Rome, sent as a representative of the Italian Government.

Furthermore, most of the members of the foreign service committee of the council, who have been in France and England for a period of two or three months, have returned to the United States and have brought with them much valuable informatoin relative to the organization and development of scientific activities in connection with the war. A few members of the committee have remained in France to continue their observations and investigations, under special detail. Formal reports have been submitted to the council, through its executive and military committees, relating to the observations and experiences of the members of this committee, in connection with which recommendations for cooperative investigations in this country are made.

The special committees of the council on the subjects of optical glass and noxious gases have submitted reports, which in turn have been transmitted by the executive committee of the council to the General Munitions Board and the Council of National Defense. As a result, arrangements have been made for providing the government with optical glass through cooperation between the Bureau of Standards, the geophysical laboratory of the Carnegie Institution of Washington, the Bausch & Lomb Optical Company, and the Pittsburgh Plate Glass Company. Researches on noxious gases have been placed under the charge of the director of the Bureau of Mines, acting in cooperation with the army and navy and the committee on noxious gases of the National Research Council.

It is expected that announcement may be made at a later date relative to problems initiated by the various committees of the council and means for their solution.

A number of friends have generously contributed to provide funds for the expenses of the council. It is also a pleasure to announce that at a recent meeting of the Carnegie Corporation of New York, the following resolution was passed:

> *Resolved*, That the sum of fifty thousand dollars ($50,000) or so much thereof as may be necessary, be and it hereby is appropriated to the Carnegie Institution of Washington, to be expended in the discretion of the president of said institution to meet expenses incurred by the National Research Council during the war; and that the treasurer be and he hereby is authorized to make payments as needed on the certificate of the Carnegie Institution of Washington.

PSYCHOLOGY AND NATIONAL SERVICE

Among the many scientific problems which the war has forced upon the attention of our military authorities there are several which are either psychological or present a psychological aspect. In the opinion of experts many of these problems are immediately soluble and it therefore becomes the duty of professional psychologists to render national service by working on such problems. For this reason a committee on psychology has been organized, with the approval of the council of the American Psychological Association, by the National Research Council. This committee consists of J. McKeen Cattell, G. Stanley Hall and E. L. Thorndike from the National Academy of Sciences; Raymond Dodge, S. I. Franz and G. M. Whipple from the American Psychological Association, and C. E. Seashore, J. B. Watson and R. M. Yerkes, chairman and member of the National Research Council, from the American Association for the Advancement of Science.

At the first meeting of the committee, it was voted "that whereas psychologists in common with other men of science may be able to do invaluable work for national service and in the conduct of the war, it is recommended by this committee that psychologists volunteer for and be assigned to the work in which their service will be of the greatest use to the nation. In the case of students of psychology, this may involve the completion of the studies on which they are engaged."

It is the function of this general committee to organize and, in a general way, supervise psychological research and service in the present emergency. Problems suggested by military officers or by psychological experts are referred by the committee to appropriate individuals or institutions for immediate attention. Already at the suggestion of the council of the American Psychological Association the chief psychological laboratories of the country have been offered to the committee for such use as the military situation dictates. Moreover, the membership of the American Psychological Association, in response to a letter addressed to it by the council, has responded most promptly and heartily with offers of personal service.

At a meeting held in Philadelphia, April 21, the council of the American Psychological Association, in addition to approving and urging the appointment of a committee on psychology for the National Research Council, authorized the organization of twelve committees to deal with various important aspects of the relations of psychology to the war.

The list of committees with their personnel, so far as at present announced, follows, together with brief comment on the status of their work:

COMMITTEES

Committee on psychological literature relating to military affairs. It is the function of this committee to prepare bibliographies and abstracts of important psychological military contributions for the immediate use of committees, individual investigators and for publication. Chairman, Madison Bentley, University of Illinois.

Dr. Bentley already has rendered valuable service to several of the committees.

Committee on the psychological examining of recruits. The first task of this committee is the preparation, and standardization of methods and the demonstration of their serviceableness. Chairman, Robert M. Yerkes, Harvard University, W. V. Bingham, Henry H. Goddard, Thomas H. Haines, Lewis M. Terman, F. L. Wells, G. M. Whipple.

This committee has prepared a method of group examining, and also varied methods of individual examining. The work, covering a period of four weeks, was generously financed by the Committee on Provision for the Feebleminded. The methods are now (July 25) being tested in three army camps and one naval station. The expense of this initial trial, which is made primarily for the further development and perfecting of the methods, is met by an appropriation of twenty-five hundred dollars made by the Committee on Furnishing Hospital Units for Nervous and Mental Disorders to the United States government. At the present writing, the surgeon general of the Army awaits lists of psychologists who are both adequately prepared and willing to serve as psychological examiners.

It is the conviction of the committee that the psychological examiner, by applying specially prepared and adapted methods to recruits in the camps, should obtain measurements valuable alike to line officers, to general medical officers, and to the special officers in charge of the psychiatric hospital units.

It is assumed that the work of psychologists, although not strictly medical in character, but instead vocational, educational and social, will supplement that of the medical examiner by supplying him with information otherwise not available. Further, the psychologist may aid the psychiatrist by detecting and referring to him those individuals for whom careful psychiatric examination is obviously desirable.

Committee on the selection of men for tasks requiring special skill. This includes the selection and promotion of officers, as well as choice of men for varied kinds of skilled service. Chairman, Edward L. Thorndike, Columbia University, J. C. Chapman, T. L. Kelley, W. D. Scott.

A method of selecting officers devised by Dr. Scott is now in use in many of the Officers Training Camps.

Committee on psychological problems of aviation, including examination of aviation recruits. Chairman, H. E. Burtt, Harvard University, W. R. Miles, L. T. Troland.

Work looking toward the development and thorough testing of methods for the selection of aviation recruits has been authorized by the Government and already is in progress in at least one of the institutions where the recruits are being trained.

Committee on the psychological problems of incapacity, especially those of shock, reeducation and vocational training. Chairman, S. I. Franz, Government Hospital for the Insane, K. S. Lashley, J. B. Watson.

The task proposed for this committee is a large and difficult one and the chairman plans to organize, in intimate relations with various military activities and agencies, a committee which shall be competent to deal with the varied scientific problems of incapacity.

Dr. Franz has himself developed methods for the reeducation of certain paralytics, and according to our information his methods are now used by the Military Hospitals Commission of Canada. It is greatly to be hoped that his own country may be equally ready to avail itself of these methods, and that it may adequately prepare in advance for the extremely important as well as difficult task of rehabilitating maimed and paralyzed soldiers and sailors.

Committee on psychological problems of recreation in the Army and Navy. Chairman, George A. Coe, Union Theological Seminary, W. C. Bagley, H. L. Hollingworth, G. T. W. Patrick, J. H. Tufts.

This committee will serve the national cause by cooperating in every profitable way with the committee on military recreation of the Y. M. C. A. and with such other agencies as are immediately concerned with this kind of military aid. Psychologists will find abundant opportunity for the study of psychological aspects of recreational problems.

Committee on pedagogical and psychological problems of military training and discipline. Chairman, Charles H. Judd, University of Chicago.

Committee on problems of motivation in connection with military service. Chairman, Walter D. Scott, Northwestern University, H. S. Langfeld, J. H. Tufts.

Committee on problems of emotional stability, fear and self-control. Chairman, Robert S. Woodworth, Columbia University, W B. Cannon, G. Stanley Hall, J. B. Morgan, J. F. Shepard.

It is probable that in addition to dealing with the special problems of emotional stability this committee will find it desirable to undertake a careful study of incorrigibility.

Committee on acoustic problems of military importance. Chairman, Carl E. Seashore, University of Iowa, R. M. Ogden, C. A. Ruckmich.

Already the chairman of this committee has interested himself in the relations of the principles of acoustics to various naval situations. Methods of localizing sounds and their utilization for the detection of submarines, the identification of guns, and the locating of batteries are clearly important. These questions are under investigation by the physics committee of the National Research Council, with which Dr. Seashore's committee will cooperate.

Committee on visual problems of military significance. Chairman, Raymond Dodge, Wesleyan University, R. P. Angier, H. A. Carr, L. R. Geissler, S. P. Hayes, G. M. Stratton, L. T. Troland.

Chairman Dodge has devised and perfected an apparatus for the measurement of various important aspects of the naval gunners reaction. This is now installed for trial on a number of battleships. The committee has also been requested to prepare and recommend to the Navy methods for the selective examinating of men for various kinds of service. This work is in progress and its results will shortly be reported to the officials directly concerned.

If the war continues for as much as a year American psychologists will have opportunity to serve importantly, not only in the examining and classifying of recruits but also in the selection of men for positions of responsibility, and in the choice and training of aviation recruits, naval gunners and others in skilled service. It is no longer a matter, as at first appeared to be the case, of inducing military authorities to accept methods of psychological measurement, but instead primarily one of meeting their expressed needs and requests for assistance.

As psychological research along such lines as have been indicated above progresses and as the applicability and serviceability of methods are demonstrated, it is probable that effective use can be made by the government of all scientists who are skilled in the study and control of human behavior. For after all, the human factors in the war are as important as are the mechanical and it can not be doubted that brains and not brawn will decide the great conflict.

R. M. YERKES,
Chairman

WILLIAM BULLOCK CLARKE

Dr. William Bullock Clarke, professor of geology in the Johns Hopkins University, eminent for his contributions to geology, died suddenly from apoplexy on July 27, at his summer home at North Haven, Maine.

Wm. Bullock Clarke was born at Brattleboro, Vermont, December 15, 1860. His parents were Barna A. and Helen (Bullock) Clark. Among his early ancestors were Thomas Clark, who came to Plymouth, Mass., in the ship *Ann* in 1623 and who was several times elected deputy to the general court of Plymouth Colony; Richard Bullock who came to Salem, Mass., in 1643; John Howland, a member of council, assistant to the governor, and several times deputy to the general court of Plymouth Colony, who came to Plymouth in the *Mayflower* in 1620; John Tilly who likewise came in the *Mayflower;* and John Gorham, captain of Massachusetts troops in King Philip's War. Among later ancestors were William Bullock, colonel of Massachusetts troops in the French and Indian War, and Daniel Stewart, a minuteman at the battle of Lexington in 1775.

Clark studied under private tutors and at the Brattleboro high school, from which he graduated in 1879. He entered Amherst College in the autumn of 1880 and graduated with the degree of A.B. in 1884. He immediately went to Germany and from 1884 to 1887 pursued geological studies at the University of Munich from which he received the degree of Doctor of Philosophy in 1887. Subsequently he studied at Berlin and London, spending much time in the field with members of the geological surveys of Prussia and Great Britain.

Before leaving Munich Dr. Clark was offered and accepted the position of instructor in the Johns Hopkins University. He was instructor from 1887 to 1889, associate from 1889 to 1892, associate professor from 1892 to 1894, and professor of geology and head of the department since 1894. He has been for a long time a member of the academic council—the governing body of the university—and always took a very active interest in its affairs, acting as one of the committee of administration while the university was without a president.

In 1888 he was also appointed an assistant geologist on the U. S. Geological Survey and detailed for work on the Cretaceous and Tertiary formations of the Atlantic Coastal Plain. At the same time he was requested to prepare the correlation bulletin on the Eocene, one of a series of reports which were presented to the International Geological Congress in Washington in 1891. Professor Clark spent the summer of 1889 in a study of the Eocene deposits of the far west while the remaining period was occupied in the investigation of the Eocene formations of the Atlantic border. He was advanced to geologist on the staff of the U. S. Geological Survey in 1894 and held this position until 1907, since which time he has acted as cooperating geologist.

Professor Clark organized the Maryland State Weather Service in 1892 of which he was appointed the director. He has held the position continuously to the present time. In 1896 he organized the Maryland Geological Survey and has been state geologist since the establishment of that bureau. The Geological Survey was enlarged in scope in 1898 by the addition of a highway division which was instructed to investigate and report on the conditions of the roads of the state and the best means for their improvement and Professor Clarke and his associates through their publications and addresses aroused much interest in the subject throughout the state. In 1904 the duties of the highway division were much increased by the appropriation of $200,000 annually to be met by a similar amount from the counties for the building of state aid roads by the survey. A sum exceeding $200,000 was also subsequently appropriated for the building of state aid roads by the survey, at the expense of the state alone, of a highway connecting Baltimore and Washington. The duties of the highway division were transferred in 1910 to a newly organized State Roads Commission, of which Professor Clarke was made a member and which position he held until 1914. Nearly $2,000,000 had been expended, however, by the State Geological Survey in the supervision and building of roads up to the date of the transfer.

Under an Act of the Legislature passed in 1900 Professor Clarke was appointed commissioner for Maryland by the governor to represent the state in the resurvey of the Maryland-Pennsylvania boundary, commonly known as the Mason and Dixon line. This survey was completed four years later and an elaborate report prepared. In 1906 he was made a member of the Maryland State Board of Forestry and elected as its executive officer, which position he held at the time of his death. The governor appointed him in 1908 a member of the State Conservation Commission.

Professor Clarke organized and directed the preparation of the official state exhibits of Maryland mineral resources at the Buffalo, Charleston, St. Louis, Jamestown, and San Francisco expositions in 1901, 1902, 1904, 1907, and 1915. These exhibits attracted much attention at the time and received a large number of conspicuous awards. These exhibits have been permanently installed as a state mineral exhibit at the state house in Annapolis.

When President Roosevelt invited the governors of the states to a conference on conservation at the White House in May, 1908, it was arranged that each governor should appoint three advisers to accompany him. Professor Clark was one of the Maryland advisers and took part in the conference.

After the great Baltimore fire in 1904 the mayor of the city appointed Professor Clarke a member of an emergency committee to prepare plans for the rehabilitation of the burnt district and for several months he served as vice-chairman of the important subcommittee on streets, parks, and docks whose plans resulted in the great changes subsequently carried out. The following year he was appointed by the mayor a member of a committee to devise a plan for a sewerage system for the city which has resulted in the building of the present modern system of sewers. Again in 1909 the mayor also appointed him a member of a committee for devising a plan for the development of a civic center for Baltimore.

Since 1901 Professor Clark has been president of the Henry Watson Children's Aid Society of Baltimore and was a delegate to the White House Conference called by President Roosevelt in February, 1909, to consider the subject of the dependent child. He was also a member of the executive committee of the State Tuberculosis Association and a vice-president and chairman of the executive committee of the federated charities of Baltimore.

Numerous scientific societies have elected him to membership, among them the National Academy of Science, of which he was chairman of the Geological Section, the American Philosophical Society, the Philadelphia Academy of Natural Sciences, the American Academy of Arts and Sciences, the Deutsche Geologische Gesellschaft, the Washington Academy of Science, Paleontologische Gesellschaft, and the American Association for the Advancement of Science. He was councillor and treasurer of the Geological Society of America at the time of his death. In 1904 he was elected a foreign correspondent of the Geological Society of London. He was also president of the Association of State Geologists. Amherst conferred on him the degree of LL.D. in 1908. He had numerous offers from other institutions, perhaps the most important being the professorship and head of the department of geology at Harvard University, but all of these were refused, and his devotion to Hopkins and the ideals for which it stood was unswerving.

At the time of the International Geological Congress in St. Petersburg in 1897 Professor Clarke was an official delegate from the United States and spent several months in an extended trip through Russia and its provinces. In 1906 he spent the summer on an expedition to central Alaska, visiting the region to the north of Prince William Sound. He traveled extensively in western America and Mexico, reaching distant portions of the western Sierra Madre district.

With the outbreak of the war Professor Clarke became actively interested in problems of defense and economic preparedness. He was appointed a member of the National Research Council and was chairman of the subcommittee on road materials and a member of the committee on camp sites and water supplies. He was also chairman of the committee on highways and natural resources of the Maryland Council of Defense.

Professor Clarke made numerous contributions to geological literature, his work being confined largely to the Cretaceous and Tertiary formations of the Atlantic Coastal Plain and the Carboniferous deposits of the central Appalachian region. Professor Clarke's chief paleontological interest was centered in the Echinoidea, to the elucidation of which group he published several monographs. One of his monuments will be the series of reports of the Maryland Geological Survey, which set a new standard for state publications both as to subject-matter and book-making. The systematic reports in which he was most interested will be of perennial service to science

He was a member of numerous clubs including the University, Maryland, of which he was a vice-president, Baltimore Country, Johns Hopkins, and City Clubs of Baltimore and the Cosmos Club of Washington.

He was married October 12, 1892, to Ellen Clarke Strong, daughter of the late Edward A. Strong, of Boston, and had four children, Edward Strong, Helen, who was recently married to Captain H. Findlay French, Atherton and Marion, all of whom survive him.

Professor Clarke's administrative ability and professional attainments are largely responsible for the extensive development of Maryland's mineral resources and his loss will be severely felt in all quarters. He was always keenly interested in the educational value of the work of the various state bureaus which he directed and had just finished writing a geography of Maryland for school teachers. At the time of his death he was engaged in writing a report on the underground waters of the state and another on the coals.

SCIENTIFIC EVENTS

THE ASIATIC ZOOLOGICAL EXPEDITION OF THE AMERICAN MUSEUM OF NATURAL HISTORY

Dr. Henry Fairfield Osborn, president of the museum, has received news from Mr. Roy C. Andrews, who is in charge of the expedition. The principal work of the expedition was done in remote regions of the province of Yunnan, China, where no white man had ever been seen before the explorer and his party entered that region. Mr. Andrews is accompanied by Mrs. Andrews, who is the official photographer of the expedition. The party, since it has been in Yunnan, has ridden 2,000 miles on horseback and made camps in 107 different localities varying from 1,700 to 15,000 feet above the level of the sea. Mr. Andrews says in his report, which is dated at Hui-Yao, May 23, 1917:

> The active field work of the expedition ceases to-morrow, exactly one year since it began by our first trip up the Min River from Foochow—a trip which was interrupted rather seriously by the rebellion, but which gave us some very interesting experiences. We have as results the following: 2,100 mammals, 800 birds, 200 reptiles, 75 skeletons of mammals, 8,000 feet of motion-picture film, 150 Paget natural color photographs, 300 black and white negatives. Our attention to the subject of mammals has, I believe, yielded the largest collection ever taken out of China by a single expedition. We visited first the northern alpine country along the Thibetan frontier where we were seldom below an altitude of 9,000 feet and collected as high as 15,000 feet. The mountains among which we were working were tremendous, reaching as high as 18,000 feet. In this region we were frequently with natives who had never seen a white person. The northern trip occupied some four months and we then started on a long journey southward to the Burma border where we collected in regions only 1,700 feet above sea level, where, of course, we found a totally different fauna. Thus the collection covers a wide range of climate as well as actual distance. Our large mammals include seven gorals (*Nemorhaedus*) from the Thibetan region and four serows (*Nemorhaedus*) —all complete with accessory material for group mounting. On the Burma frontier we collected twenty-five gorals—a perfectly splendid series, all from one mountain and of all possible ages from just born, young to very old males and females.

I do not hesitate in saying that this is the finest series of these rare animals in any museum of the world. It is quite a different species from those we shot in the north. A few days ago I had the good fortune to shoot a splendid coal-black serow—an animal quite unlike the serows of the Thibetan border and exceedingly rare in this region. We have also arranged to buy a fine male serow from Fukien Province. This gives us six of these strange animals of three different species. We have a very large sambur (*Rusa*) stag in perfect mountable condition, ten red barking deer (*Cervulus*) and two of the very rare blue, or crested, muntjacs (*Elaphodus*). The collection contains twenty-five monkeys of five species and four genera. Two species of gibbons (*Hylobates*), one very small yellow one, and another large black variety, as well as eleven large gray monkeys (*Semnopithecus*) of all ages and sexes. Six or seven baboons of two species. Of medium-sized carnivores we have about 50—especially Viverrines, and one fine leopard.

The large mammals of this province, as indeed throughout all China, are by no means abundant, and are in widely separated districts, so that we feel we have a fairly good proportion. The collection of small mammals is especially rich in Insectivores, and I believe that some remarkable types will be found among them.

The collection of skeletons comprises all species of large or medium sized mammals, and specimens of each species of small mammal in formalin. Also fœtal examples of gibbon, goral, muntjac, langur, baboon, etc., in formalin.

We collected birds whenever we were not occupied with mammals and during our long journeys between collecting points. About one third of the collection is from Fukien Province and the remainder from Yunnan.

Neither Mr. Heller nor myself has ever been in such a poor reptile country. Some five months of the trip, while we were in the north, the weather was so cold that no reptiles at all were to be found. Those we have collected were mostly taken during the few months of our southern trip.

The photography of the expedition will, I believe, prove of extraordinary value and interest, comprising, as it does, motion film, natural color and black and white negatives. The Paget color plates will be especially interesting, and have not, I believe, ever been used upon an expedition of this character before. The motion film shows the general life of the people along the Thibetan border and in the far south, and, since it was developed in the field, the success of the film, from a technical standpoint, is assured.

We have met with the greatest courtesy from all officials with whom we have come in contact. The Chinese government has granted willingly every request which we have made, and French and British officials have given us free entry of goods, reduced freight rates and assisted in various other ways.

Mr. Andrews will leave Mr. Heller at Bhamo and proceed to Calcutta, where he expects to spend a week or ten days at the museum comparing a selected series of his collection of small mammals with those obtained by the Anderson Yunnan Expedition in 1875—the only other expedition which has ever collected in that province. He will then go to Colombo and tranship for Hong Kong—a journey of twenty days or more. From Hong Kong, Mr. Andrews will return direct to New York, arriving about the end of September or the first of October. Mr. Heller will probably spend some time traveling in India, but will no doubt reach New York about the same time.

WAR SERVICE OF CHEMISTS

DR. JULIUS STIEGLITZ, president of the American Chemical Society, and Dr. Charles L. Parsons, secretary, have, under date of July 24, addressed the following letter to the members of the American Chemical Society:

In accordance with the resolutions passed by the society at the Kansas City meeting, the officers of your society have been urging the government that chemists, as in England, Canada and France, be used for chemical service in the war, either in the employ of the military branch, of the other government branches, or of necessary industries. A special committee was organized by your president, consisting of Dr. W. H. Nichols, chairman, Drs. M. T Bogert, A. A. Noyes, your secretary and your president, to lay definite recommendations before the authorities. These have been published in the July number of the *Journal of Industrial and Engineering Chemistry*.

The government, it appears, has decided that there will be no general exemption of any class of men as a class—for reasons which are eminently wise and necessary at the present moment. At the same time, no doubt, it is anxious to see every man used in what appears to it to be the right place for him. It has seemed perhaps best to make no general ruling whatsoever, except to the effect that there will be no class exemptions, and to leave all individual cases to the federal district exemption boards, to which exemptions for industrial, agricultural and professional reasons are left by law.

Under the circumstances, in the absence of instructions from the government and in view of the general desire on the part of our members for guidance and advice in this matter, we would recommend to you *unofficially* the following procedure: Chemists of military age selected by draft for service and accepted by the local boards to which the physical examination, etc., is committed are advised to submit to their federal district boards:

1. An official certificate of their employers, or of the university or college from which they have received degrees or with which they have been or are connected, certifying as to their education and experience as chemists.
2. An official statement by their employers of the nature of their work as chemists.
3. A recommendation, if such seems right, from their employers, or their university or college, that they be assigned to continue their work as chemists.
4. A request that in default of such assignment, they be detailed to serve as chemists in the military branch of the government.
5. If enlisted in any capacity, inform the secretary of the society by postal card of the company, regiment and corps in which you are enrolled, in order that a record may be kept of the fact and the War Department advised from time to time of chemists in the army should their services as chemists be required.

The purpose of this recommendation is to put into the possession of the government authorities all the facts necessary for it to decide exactly for what service a given man is most fitted. We believe this to be in accordance with the resolutions adopted at the Kansas City meeting and in accordance with the patriotic duty of every American chemist to serve his country under the selective draft in the capacity the government itself, with a full knowledge of the circumstances, selects for each individual.

THE BOSTON MEETING OF THE AMERICAN CHEMICAL SOCIETY

THE September meeting of the American Chemical Society will be held in the buildings of the Massachusetts Institute of Technology, Charles River Road, Cambridge, Mass., September 11, 12 and 13, 1917. The Northeastern Section has been requested by the directors to omit the usual annual banquet and excursions, and to arrange a program characterized by simplicity and seriousness, and bearing as fully as possible on questions concerning the activities of chemists—both in the government service and in the industries during the war.

The following is a list of the chairmen of local committees:

Executive.—H. P. Talbot, Massachusetts Institute of Technology, Cambridge, Massachusetts.
Finance.—A. D. Little, 93 Broad Street, Boston, Massachusetts.
Registration.—K. L. Mark, Simmons College, Brookline, Massachusetts.
Entertainment.—R. S. Williams, Massachusetts Institute of Technology, Cambridge, Massachusetts.
Press and Publicity.—R. W. Neff, 22 India Square, Boston, Massachusetts.
Entertainment of Ladies.—Mrs. A. D. Little.

Registration will be conducted at the buildings of the Massachusetts Institute of Technology, Cambridge, except on Monday, September 10, when it will be held at the Hotel Lenox. Society headquarters will be at the Hotel Lenox at the corner of Boylston and Exeter Streets. The use of the Engineers' Club, at the corner of Arlington Street and Commonwealth Avenue, will be extended to all members of the society.

PROGRAM

Monday, September 10

4 P.M.—Council meeting. Engineers' Club.

7 P.M.—Dinner to the Council at the Engineers' Club (tendered by the Northeastern Section).

Tuesday, September 11

10 A.M.—General meeting of the society in the Massachusetts Institute of Technology.

Address of Welcome: Dr. R. C. Maclaurin, president, Massachusetts Institute of Technology.

Response: Julius Stieglitz, president, American Chemical Society.

General papers:

2 P.M.—General Conference on Chemistry and Chemistry in Warfare, opened by William H. Nichols, chairman, committee on chemicals, Council of National Defense. Marston T. Bogert, chairman, chemistry committee, National Research Council.

5 P.M.—Harbor trip to Hotel Pemberton, where an informal shore dinner and smoker will be held.

Wednesday, September 12

Morning.—Conferences of Divisions.

Afternoon.—Divisional Meetings.

Evening.—President's address, Huntington Hall, Rogers Building, Massachusetts Institute of Technology, Boylston Street.

Thursday, September 13

Morning and Afternoon.—Divisional Meetings.

The usual meetings, including the annual election of officers, will be held by all the Divisions, and by the Rubber Chemistry Section, with the following special program:

Physical and Inorganic and Organic Divisions may hold a joint conference on Wednesday morning, September 12.

Division of Industrial Chemists and Chemical Engineers, Wednesday, September 12. Conference on "The industrial chemist in war time."

Division of Organic Chemistry will hear and discuss the report of the committee on "The supply of organic chemicals for research during the war," by the chairman, C. S. Hudson.

Division of Pharmaceutical Chemistry.—Conference on "Pharmaceutical chemistry and the future," opened by L. F. Kebler. The secretary of the Division wishes to call the attention of the members to the fact that papers on the composition of plant drugs or any of their constituents, the composition of volatile oils, etc., are appropriate to the program of this division. Papers on pharmacological testing should also be presented to this division.

The Fertilizer Division will have papers of unusual interest dealing with the fertilizer situation of to-day in relation to the chemical methods employed in the analysis of fertilizers, sampling of fertilizers, etc. A conference where the papers previously read will be freely discussed and general conditions affecting the fertilizer business from a chemical standpoint will close the meeting.

Division of Biological Chemistry. The sessions of the Biochemical Division include for Wednesday a special program concerning "Enzymes and their action."

Division of Water, Sewage and Sanitation will hold a conference on "Sanitation in warfare."

All titles for papers should be in the secretary's hands on or before August 27; or in the hands of the secretaries of divisions on or before August 25, with the exception that titles of papers should reach the secretary of the Division of Industrial Chemists and Chemical Engineers on or before August 21. In order that the meeting may receive due and correct notice in the public press, every member presenting a paper is requested to send an abstract to Professor Allen Rogers, Pratt Institute, Brooklyn, N. Y., chairman of the society's press and publicity committee. The amount of publicity given to the meeting and to the individual papers will entirely depend upon the degree to which members cooperate in observing this request. A copy of the abstract should be retained by the member and handed to the secretary of the special division before which the paper is to be presented in Boston or, better, sent in advance of the meeting to R. W. Neff, 22 India Square, Boston, Mass. Short abstracts will be printed in SCIENCE.

The final program will be sent to all members signifying their intention of attending the meeting, to the secretaries of sections, to the council, and to all members making special request therefor.

CHARLES L. PARSONS,
Secretary

SCIENTIFIC NOTES AND NEWS

PROFESSOR LIONEL S. MARKS, head of the combined departments of mechanical engineering of Harvard University and the Massachusetts Institute of Technology, has been appointed to take charge of investigations relating to airplane engine design being conducted by the national advisory committee for aeronautics at the Bureau of Standards.

PROFESSOR WILLIAM D. HURD, director of the extension service of the Massachusetts Agricultural College, has been called to Washington to act as assistant to the Secretary of Agriculture.

A COMMITTEE on industrial fatigue has been organized under the advisory commission of the Council of National Defense with the following membership: Dr. Thomas Darlington, New York, chairman; Professor Frederic S. Lee, Columbia University, executive secretary; Professor Robert E. Chaddock, Columbia University; Professor Raymond Dodge, Wesleyan University; Dr. David L. Edsall, Harvard Medical School; Mr. P. Sargant Florence, Columbia University; Miss Josephine Goldmark, National Consumers

League; Professor Ernest G. Martin, Leland Stanford University; Dr. J. W. Schereschowsky, Public Health Service; Dr. Ernest L. Scott, Columbia University. The committee is investigating munition factories and other industrial establishments that are manufacturing war supplies, with the view of showing how avoidable fatigue may be eliminated and how the greatest output of the necessities of war may be secured compatible with the maintenance of the working-power of the workers.

Dr. Horace D. Arnold, of Boston, has been elected chairman of the Council on Medical Education of the American Medical Association, succeeding Dr. Arthur Dean Bevan, of Chicago.

Dr. Leverett D. Bristol has been appointed state health commissioner of Maine.

Dr. J. Ehrlich has been appointed chief chemist of the Verona Chemical Company, North Newark, N. J.

Sir George Newman, chief medical officer of the British Board of Education, has joined the committee appointed by the president of the Board of Agriculture to investigate the production and distribution of milk.

Sir Malcolm Morris has been elected president of the Institute of Hygiene, London, in succession to Sir William Bennett, who has held the post for the past ten years, and will continue his association with the institute as vice-president.

The Harben gold medal of the Royal Institute of Public Health of Great Britain, given every third year for eminent services rendered to the public health, has been awarded this year to Surgeon-General Sir Alfred Keogh, G.C B., director-general of the Army Medical Service, and the gold medal for conspicuous services rendered to the cause of preventive medicine to Dr. E. W. Hope, M.O.H. for the city and port of Liverpool, and professor of public health in the university.

As has been noted in Science the annual meeting of the British Association has been given up. We learn from *Nature* that meetings of the organizing committees of the various sections, the delegates of corresponding societies, the committee of recommendations, and the general committee have now been held. It has been decided to continue Sir Arthur Evans in the presidency for another year, while the Hon. Sir C. A. Parsons, who would have presided over this year's meeting, will do so at the meeting which it is hoped will take place as arranged at Cardiff next year. The meeting this year would have been at Bournemouth, and that borough has repeated its invitation, which has been accepted, for 1919. Grants amounting to £286 were made in aid of such researches as were regarded as essential to carry on, having regard to present conditions. The new members of the council of the Association are Dr. E. F. Armstrong, Mr. J. H. Jeans, Professor A. Keith, Professor W. H. Perkin, and Mr. W. Whitaker.

We learn from *The British Medical Journal* that at a recent meeting of the administrative council of the Pasteur Institute, Paris, Dr. Albert Calmette, director of the Pasteur Institute at Lille, and Dr. Louis Martin, director of the Pasteur Hospital, were unanimously appointed subdirectors in the room of Dr. Chamberland and Professor Metchnikoff. Dr. Chamberland, who died in 1908, has had no successor till now. Dr. Calmette, who founded the Pasteur Institute at Saigon, has taken a leading part in the campaign against tuberculosis in France, and Dr. Martin, who has been associated with the Paris Institute since 1902, has made researches on the bacteriology of diphtheria, the prophylaxis of contagious diseases, tuberculous meningitis, tetanus, anthrax, and sleeping sickness. At the same meeting M. Vallery-Radot, Pasteur's son-in-law and biographer, was elected president of the administrative council.

Dr Harold C. Bradley, professor of physiological chemistry in the University of Wisconsin, recently delivered an address on "Autolysis and the mechanism governing atrophy and hypertrophy of tissues" before the faculty and students of the graduate summer quarter in medicine of the University of Illinois.

Professor G. A. Miller, of the University of Illinois, will contribute the article on mathematics for the 1917 edition of the

"American Year Book," succeeding Professor E. B. Wilson, who was recently appointed head of the department of physics in the Massachusetts Institute of Technology.

David Wendell Spence, for twenty-seven years a professor of civil engineering, and for the past ten years dean of the school of engineering and professor of civil engineering in the Texas College, died at Galveston on June 28.

Dr. Charles Baskerville, professor of chemistry in the College of the City of New York, has been appointed by the Ramsay Memorial Committee to organize a committee in the United States for receiving subscriptions to the fund from Americans.

UNIVERSITY AND EDUCATIONAL NEWS

Announcement is made that a gift of $50,000 from George W. Brackenridge of San Antonio, Tex., will enable Columbia University to open its doors to women students this autumn. Work will be begun at once on the addition to the present building to provide extra laboratory facilities in the departments of chemistry, pharmacology, pathology and bacteriology.

Professor Benjamin T. Marshall, of Dartmouth College, has been appointed president of Connecticut College for Women at New London, to succeed President Frederick Sykes.

Dean W. G. Raymond, head of the College of Engineering of the State University of Iowa, has declined the presidency of the Colorado school of mines situated at Golden, Colo.

Dr. Hugh McGuigan, professor of pharmacology in the Northwestern University, has accepted the position of professor and head of the department of pharmacology, materia medica and therapeutics in the college of medicine of the University of Illinois.

Dr. H. R. Crosland of the department of psychology of the University of Minnesota, has been elected assistant professor of psychology in the University of Arkansas.

Lord Crewe has accepted the invitation to become chancellor of the University of Sheffield, in succession to the late Duke of Norfolk.

DISCUSSION AND CORRESPONDENCE

REPLY TO DR. ERLANGER

On p. 384 et seq., Vol. XLV, of this journal Dr. Erlanger criticizes an abstract of my paper which he did not stop to hear and which is not yet published.

Dr. Erlanger completely misses the point of my paper and somewhat radically changes some statements in his own paper.[1]

Dr. Erlanger stated that the pressure oscillations are in direct numerical ratio to the *manometer* pressures in the compression chamber; I showed that the ratio is determined by the barometric plus the manometric pressure—*i. e.*, Boyle's Law.

He says.[2]

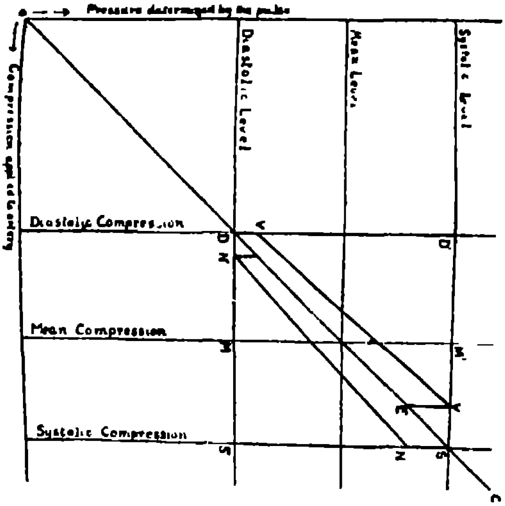

Fig. 1.

> Inasmuch as the volume of incompressible fluid entering the artery is practically the same throughout the diastolic-systolic range of compression and since at this time, as premised above, the compression pressure is nearly twice that which obtained at *D*, the pressure in the compression chamber will be raised almost twice as high by the

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[1] Erlanger, *Am. Jour. Physiol.*, 1916, XXXIX, 401.

[2] *Loc. cit.*, 409.

pulse at E as at D; for the rise of pressure determined by the addition of a given volume of incompressible material to a confined gas-filled space is proportional to the pressure of the gas filling the space.

This statement is also expressed in the diagram[3] which is here given in photographic reproduction. The beginning pressure is marked zero—*i. e.*, ignoring barometric pressure—the "diastolic pressure" marked on the ordinate is just half way between zero and the "systolic pressure." The ordinates drawn to represent the extent of oscillations are in the same ratio, that is the "systolic rise"—EV'—at double the *manometer* pressure is just twice that marked at N near DV for diastolic pressure—a ratio of 1: 2.

Boyle's Law shows that the ratio would be P'/P where P is the original *total* pressure; P' the new pressure produced by the addition of a constant volume of fluid. Accordingly: introducing V and V' as the respective volumes of the gas with K as the constant it was found in a concrete case where V was 100 c.c. and where 1 c.c. of fluid was added with the barometer at 747 mm. that the ratio of the size of the oscillations at 50 mm. (manometer) beginning pressure as compared with 100 mm. (797 mm. and 847 mm. total pressure) was 8.05: 8.55 or 1: 1.06 plus instead of 1: 2 as per Erlanger hypothesis.

The ratio at 0 mm. (manometer) beginning pressure as compared with 100 mm. (manometer pressure was 7.54: 8.55 or 1: 1.13 instead of 1: *infinity* as demanded by the Erlanger hypothesis.

A. M. Bleile

Ohio State University,
Columbus

FAUNAL CONDITIONS IN SOUTH GEORGIA

Regarding Mr. Luke's note on the rats of South Georgia,[1] it may be of interest to record that his question as to "what characteristics the rat would develop after a few years of such a specialized habitat" has been at least provisionally answered by the Swedish zoologist, Dr. Einar Lönnberg. This author in 1906 described the South Georgia rat as a new subspecies,[2] and noted that it apparently differed from the typical brown rat in having a thicker skin, denser and longer fur, and a more rusty color.

Several of Mr. Luke's observations would be hard to substantiate, for instance the statement:

> Until about thirty years ago there were no rats on the islands.

It is much more probable that these ubiquitous rodents were introduced in sealing vessels not long after American and British sealers first began to exploit South Georgia on a large scale, which was in the year 1800. Klutschak, who visited South Georgia in 1877, transcribed and published an American sealer's chart of the island, and designated as "Rattenhafen"[3] the bay known to modern Norwegian whalemen as "Prince Olaf Harbor," but called "Port Gladstone" on the latest British map. Rats are still exceedingly abundant about this inlet, as I found in 1913. Within recent years rats are known to have been reintroduced repeatedly at Cumberland Bay.

The rats at South Georgia can not fairly be accused of having "devastated the few small animals living on the island," unless the birds are meant; there are no other native land vertebrates. Rabbits were introduced about 1872 by a sealer coming from Tristan da Cunha, and perhaps two or three times since, but they never gained a foothold. A few horses and reindeer have been thriving there in a feral state for a number of years.

The whaling industry was started at South Georgia not "a few decades ago," but in 1904. Although the rats do feed upon the whale carcasses, as Mr. Luke writes, it would be a mistake to suppose that they are at all dependent upon this source of food, for the creatures appear to be very nearly as abundant about the uninhabited fiords as they are along the shores of the carcass-strewn bays. I observed at Possession Bay, the Bay of Isles, and elsewhere, that the rats eat the young tussock grass, and that they devour also enormous numbers of the smaller species of sea-birds (Tubinares), which nest in burrows.

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[3] *Loc. cit.*, 407.

[1] Science, N. S., XLV., 502, 503, 1917.

[2] *Kungl. Sv. Vet. Akad. Handlingar.*, Bd. 40, No. 5, 21–23, 1906.

[3] *Deutsch. Rundschau f. Geogr. u. Stat.*, Bd. III., 522–531, 1881.

I shall refer again to the rats of South Georgia in two forthcoming papers, one of which is already in type. The following references are to articles by the writer that throw light upon faunal conditions at South Georgia, and the way in which they have been affected by human agency: (1) "A Desolate Island of the Antarctic," *Amer. Mus. Journ.* XIII., 242–259, 1913. (2) "A Subantarctic Island," *Harper's Mag.* January, 1914, 165–176. (3) "Cruising in the South Atlantic," *Brooklyn Mus. Quart.* July, 1914, 83–110. (4) "A Report on the South Georgia Expedition," *Sci. Bull. Brooklyn Mus.*, II., 41–102, 1914. (5) "The Penguins of South Georgia," *Sci. Bull. Brooklyn Mus.*, II., 103–133, 1915.

ROBERT CUSHMAN MURPHY

DEPARTMENT OF NATURAL SCIENCE,
BROOKLYN MUSEUM

A PERSONAL AND FAMILY HISTORY REGISTER

TO THE EDITOR OF SCIENCE: In SCIENCE of May 16, 1913, the writer called attention to a call made by Dr. J. Madison Taylor in an earlier issue of SCIENCE, seeking aid and coöperation in a plan to secure a body of trustworthy vital statistics, and attempted to emphasize the crying need of just such a desideratum. It is gratifying to know that the aim of Dr. Taylor is now realized, and that under the above caption he has made available a means by which such data may be intelligently compiled and made permanent. The register forms a volume, quarto in size, and well bound, with provisions and directions for recording personal and family traits, history of birth, growth, health, disease, etc., and also blanks for various supplemental data that may be considered desirable in such a history, such as photographs, clinical and dental records.

The volume closes with a timely discussion of subjects relating to human welfare, and includes such topics as The Child as a Problem to Parents, The Building of a Citizen, Environment and inherited Tendencies, Personal Hygiene, Age and Age Values, Development of the Mind, all of which are presented in terms easily understood, and at the same time without sacrificing scientific accuracy.

The writer welcomes this register as a worthy contribution toward a better understanding of the importance of human statistics in relation to the imperative necessity of both human conservation and racial betterment. The author has spared no pains, and has evidently devoted long and strenuous labor in its production, and the publishers, F. A. Davis Company, Philadelphia, have also done well their part in giving to the book their usual excellence of artistic and mechanical values.

CHARLES W. HARGITT

SYRACUSE UNIVERSITY

REWARDS FOR NATIONAL SERVICE

TO THE EDITOR OF SCIENCE: The American government has embarked in what will be the greatest war in its history and as such deserves and demands the unqualified support of its citizens and that every effort be made to secure such services at the minimum cost.

An effort, I believe, is being made to organize and direct the inventive skill of the American people so as to render victory more certain, save life and property and shorten the conflict. Abroad in many cases such services are rendered gratuitously but the donator in meritorious cases is rewarded by a suitable decoration. This in many case is prized more highly than a monetary reward.

Since the government is making an effort to secure such expert inventive assistance as practicable, would it not be possible to prevail upon the government to institute such a decoration and if not for the American Association for the Advancement of Science, as the greatest organization competent to represent the consensus of expert opinion to do so.

X

SCIENTIFIC BOOKS

Konchûgaku Hanron Jôkwan (General Treatise on Entomology). By DR. T. MIYAKE.

Shōkābo, Nihonbashi, Tokyo, June, 1917, 3.50 yen.

Dr. T. Miyake, of the Imperial Agricultural Experiment Station at Nishigahara, Tokyo, has just brought out an excellent book which will serve as the first part of a handbook of entomology. It is beautifully printed in Japanese, fully illustrated, and handsomely bound. It deals with the morphology, physiology and embryology of insects, a field to which, the author states, Japanese entomologists have hitherto made very few contributions. The book is therefore largely a compilation, though here and there the researches of Japanese entomologists are quoted. The work is a pioneer of its kind, and the most detailed book that has ever appeared in Japan. It covers 347 pages and contains 227 figures. The majority of the figures are borrowed from German, American, English and other writers, and are fully credited. Some of the line drawings are apparently original and are very well done.

Dr. Miyake proposes, in his second volume, to publish a brief history of entomology in Japan. He expects to publish four volumes in all, the entire work to be used as a text-book for colleges and universities. It is a pity that European and American entomologists have such a slight knowledge of the Japanese language, for the book has a very attractive appearance and many would like to consult it.

L. O. HOWARD

HERB-GROWING IN THE BRITISH EMPIRE

The British Medical Journal states that at the meeting of the Royal Society of Arts on May 2nd Mr J. C. Shenstone, F.L.S., read a paper on herb-growing in the British empire. At the present time, he said, herbal remedies occupied a more important place in the medical and domestic practise in most European countries than they did with us. When the war broke out the discovery was made that we had become dependent upon the Central Empires not only for synthetic chemicals, but for the supply of herbal medicines formerly grown by us. Some of these plants, such as belladonna, henbane, foxglove, colchicum, and perhaps valerian and male fern, were indispensable, but although they had belonged to our native flora, or at least had been cultivated in this country from very early times, their cultivation had fallen into neglect. The same was true of less valuable plants such as the dandelion, poppy capsules, and camomile flowers. As to belladonna and henbane, it was pretty certain that their alkaloidal value could be raised considerably without increasing the cost of production, but for this purpose the cooperation of the chemist would be required. It has also been stated that the wild foxglove of this country could supply the market for digitalis. A medical friend who collected his own digitalis and prepared his own tincture had told him that he found that foxglove growing on a hot sandy bank protected by a wood gave him the best results. Experiments in producing the most active dandelion juice would be worth consideration. Liquorice, most of which came from Spain and Italy, could be cultivated in Essex and Surry, and was already grown in Yorkshire. Many valuable drugs imported from the American continent were not unsuited to our climate; *Podophyllum peltatum*, Linn., imported from America, had figured in our garden catalogues as a decorative plant. He begged medical men to give some attention, in conjunction with pharmacists and botanists, to investigating likely plants, for there could be no doubt that the varied and numerous flora of the British Empire would yield medicines of even greater value than those imported from foreign countries. Sir Robert Armstrong-Jones, who occupied the chair, said that there were eighty or one hundred medicinal herbs and plants of medicinal value; Mr. Shenstone had referred to about forty of them, but the remainder could also be grown practically within our empire. There were many reasons for the decay in the use of the medicinal herbs, but the chief was the insinuating tablet. If herb-growing were taken in hand, it should be done at once, for belladonna only paid in the second year and aconite in the third. He understood that the shortage of digitalis had now been just overcome. Sir George Savage referred to the great amount of interest he found in the old herbals in his possession, although some of them were difficult to follow. He had spent four years in a very wide country practise in Cumberland, and he recalled his indebtedness to a man who made a great many of the simpler remedies from dandelions and other plants, and saved a great deal of trouble. British bed-straw was a useful herb; in the *British Medical Journal* of forty years ago he found a note on its efficacy in certain cases. He concluded by quoting a remark of Rousseau to the effect that the field of botany had not been studied by scientists, but had been exploited by medical men who wished the public to have faith in their simples.

SPECIAL ARTICLES

THE CHEMICAL BASIS OF REGENERATION AND GEOTROPISM

1. IT is a well-known fact that in many plants after the removal of the apex some restoration of the old form is accomplished by the growth of a hitherto dormant bud near the wound. This process has been called regeneration. It is also well known that in certain fir trees the old form is restored in such a case in an apparently different way, namely by one or more of the horizontal branches next to the apex beginning to grow vertically upwards (negative geotropism). One may wonder how it can happen that the same result, namely the restoration of the old form, is accomplished in the organic world in such different ways; and it is quite natural that occurrences of this kind should suggest to one not a mechanist the conception of mystic forces acting inside or outside the living organism towards a definite purpose, in this case the restoration of the lost apex. The writer pointed out not long ago that both phenomena, the restoration of form of a mutilated organism by geotropic bending as well as by the growing out of hitherto dormant buds may be caused by one and the same agency; namely the collection of certain chemical substances near the wound.[1] New experiments which the writer has since made seem to prove this idea to be correct.

2. In a previous paper the writer had shown that when an isolated piece of stem of *Bryophyllum calycinum,* from 10 to 15 cm. long, with one leaf attached to its apical end, is put in a horizontal position the stem will gradually bend and assume the shape of a U, with the concave side upwards and that this bending is due to the active growth of a certain layer of cells in the cortex on the lower side of the stem. When the same experiment is made with stems without a leaf attached some geotropic bending of the stem still occurs, but at a much slower rate. From this observation the writer drew the conclusion that the leaf furnishes material to the stem which causes the growth of the cortex of the lower side of the stem, resulting in the subsquent geotropic bending of the stem.[2] The leaf forces this material into that part of the stem which is situated more basally than the leaf; since the part of the stem situated in front of a leaf does as a rule not show any geotropic bending. The fact that the growth leading to the geotropic curvature takes place in the cells of the lower side of a horizontally placed stem indicates that the material causing the growth collects on the lower side of the stem, which appears quite natural, since this material is a liquid, possibly containing some solid particles in suspension. A slight leakage of sap from the conducting vessels might be sufficient to account for such an accumulation of material on the under side of a horizontally placed stem.

3 Since the publication of these observations on geotropism in *Bryophyllum* the writer has been able to show that the mass of shoots which an isolated leaf can produce from its notches is a function of the mass of the leaf and that sister leaves of equal size when isolated from the stem produce equal masses of shoots under equal conditions and in equal time, even if the number of shoots produced differs considerably in the two leaves. When

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[1] Loeb, J., SCIENCE, 1916, XLIV., 210; *Bot. Gazette,* 1917, LXIII., 25; "The Organism as a Whole," New York, 1916, p. 153.

[2] *Loc. cit.*

the mass of one set of isolated leaves is reduced by cutting out pieces from their center while their isolated sister leaves remain intact the mass of shoots produced by the two sets of sister leaves varies approximately in proportion with the mass of the leaves.[8]

If it is true that the geotropic bending of a horizontally placed stem depends upon the mass of material furnished to the stem by the leaf we should expect that a reduction of the mass of the leaf would correspondingly retard the rate of geotropic bending in the stem. The writer has recently carried out such experiments and they corroborate this expectation. If two sets of stems of equal length are suspended in an aquarium, each with one leaf attached to its apical end, and if the size of the leaf is reduced in one set by cutting away pieces of the leaf, the geotropic bending takes place the more slowly the smaller the mass of the leaf. It is difficult to conceive of a more striking experiment. When the mass of the leaf is reduced to zero, the bending is extremely slow.

4. These experiments suggest that the growth of the cells of a horizontally placed stem which gives rise to the geotropic bending is accelerated by substances furnished to the stem by an apical leaf; and that these substances might be the same as those which serve for the formation of roots and shoots in the isolated leaf. If this were true, a leaf attached to a piece of stem should form a smaller mass of shoots and roots than its sister leaf entirely detached from the stem, since in the former part of the material available for shoot formation should go into the stem.

It has been known for some time that a piece of stem inhibits the shoot formation in a leaf of *Bryophyllum calycinum*, but this inhibition was attributed by former writers to an influence of roots formed on such a piece of stem. By suitable experiments it can be shown, however, that the inhibition takes place also when no roots are formed on the stem.

It seemed to the writer that the inhibiting influence of the stem on the shoot production in the leaf was due, as stated, to the absorption of material from the leaf by the stem which would have served for the growth of roots and shoots in the leaf if the latter had been detached from the stem; and that the material flowing from the leaf into the stem was causing the growth of the cells in the lower side of a horizontally placed stem, thereby giving rise to the geotropic bending of the stem (and incidentally also to the callus formation at the base of the stem). If this were true there should exist a simple quantitative relation between the inhibiting power of the stem upon shoot formation in a leaf and the increase in the mass of the stem; namely, the two quantities should be approximately equal. The writer has carried out such experiments in large numbers and found that this relation holds true, namely that a piece of stem attached to a leaf increases its weight by approximately the same amount by which the shoot production in the leaf is diminished. For these experiments the following method was adopted.

5. A piece from the stem of *Bryophyllum*, containing one node with its two leaves, is cut out from a plant and the stem split longitudinally in the middle between the two leaves, leaving one half of the stem attached to each leaf. The half stem is removed from one leaf and weighed directly. The leaf whose half stem is cut off and the leaf with a half stem still attached to it serve for the experiment. After several weeks the amount of shoots in both leaves is determined by weight and it is found that the leaf without stem had produced a larger mass of shoots than the leaf with a piece of stem attached. The latter is then removed from the leaf and weighed. It is invariably found that it has increased in weight and that this increase approximately equals the diminution in the mass of shoots in the leaf under the influence of the stem. The following may serve as an example.

Three sets of experiments were made simultaneously on 6, 7 and 7 pairs of sister leaves prepared in the way described above; one leaf was without stem and the other with one half of the split stem. The three experiments differed in regard to the length of the stem, which was in the three experiments 2 (*A*), 1 (*B*) and 0.5 cm. (*C*), respectively. The leaves dipped with their apices in water. The results are given in Table I. In this table we call the difference in the mass of shoots produced in the leaves *without* and *with* stems the inhibiting action of the stem. This quantity should equal approximately the sum of the mass of shoots produced in the axil of the leaf attached to the stem plus the increase in weight of the stem attached to the leaf during the duration of the experiment. The ratio of the two values should therefore approximately equal 1 (Table I.).

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[8] Loeb, J., SCIENCE, 1917, XLV., 436; *Bot. Gazette*, 1917 (in print).

TABLE I

DURATION OF EXPERIMENT 23 DAYS

	Shoots Produced by Leaves		Shoots Produced by Stem		Increase in Weight of Stems, Gm	Inhibiting Action of Stem
	Number	Weight, Gm	Number	Weight, Gm.		Increase in Weight of Stems (Including Weight of Shoots Produced by Stem)
Experiment A. Length of stem 2 cm. 6 pairs of sister leaves from the same plant.						
Leaves without stems......	17	1.396				
Leaves with stems..........	5	0.266	5	0 454	0.888	$\frac{1.130}{1.342}$
Experiment B. Length of stem 1 cm. 7 pairs of sister leaves from the same plant.						
Leaves without stems... ...	19	1 606				
Leaves with stems..........	13	0.823	4	0.335	0.400	$\frac{0.783}{0.735}$
Experiment C. Length of stem 0.5 cm. 7 pairs of sister leaves from the same plant.						
Leaves without stems......	15	1 006				
Leaves with stems..........	12	0.464	4	0.105	0.289	$\frac{0.542}{0.394}$

The experiments show that within the limit of error the mass of the stem increased in such a way as to approximately equal the inhibiting effect of the stem on shoot production in the notches of the leaf. The mass of roots produced in the leaves is neglected since it is small compared with the mass of stems.

It is almost impossible to split the living stem so perfectly that the two pieces are absolutely equal and in this way an error creeps in which can only be eliminated by a large number of experiments. In 19 different sets of experiments the leaves *without* stems produced 27.898 grams of shoots and the leaves *with* stems 9 797 grams. The inhibiting action of the stems, *i. e.*, the difference in shoot production between the leaves *without* stems and their sister leaves *with* stems was therefore 18.101 grams. According to our theory the weight of the stems which were left attached to the leaves should have increased by the same amount. The actual increase in the weight of the half stems attached to the one set of leaves was in the same time 16.695 grams. This includes the increase due to shoot production in the axil of the leaf, which was slight, amounting in all to less than 1.5 grams. The two values, 18.101 and 16.695 differ by 8.5 per cent.

It seems, therefore, probable that the inhibiting effect of the stem upon the mass of shoots produced in the leaves is due to the absorption of a corresponding quantity of material from the leaves by the stem.

6. *Summary and Conclusions.*—(1) The writer had shown in a former note that the mass of shoots produced in isolated sister leaves of *Bryophyllum calycinum* is in direct proportion to the masses of the leaves and that this remains true if the mass of one leaf is reduced by cutting out pieces from the center of the leaf, while the sister leaf remains intact. In this paper it is shown that the rate of geotropic bending of horizontally placed stems of *Bryophyllum calycium,* if one apical leaf is attached to the stem, occurs at a rate increasing with the mass of the leaf. When the mass of the leaf is diminished by cutting away pieces the rate of geotropic bending is diminished also.

(2) It had been known for a long time that when a piece of stem is attached to a leaf of *Bryophyllum calycinum* the shoot production in the latter is diminished or completely inhibited. It is shown in this paper that the mass of a piece of stem attached to a leaf increases by approximately the same amount by which the shoot production in the leaf is diminished through the influence of the stem. The inference is drawn that the inhibiting effect of the stem upon shoot production in the leaf is due to the fact that the same material which would have been available for shoot production in the leaf, had the latter been detached from the stem, is now absorbed by the stem.

(3) This material gives rise in the stem to callus formation and to that growth of certain cells of the cortex which causes the geotropic bending; and if the buds of the stem are not removed it causes also shoot production on the stem. The comparatively large masses involved indicate that this material must consist chiefly of the common material required for growth, *i. e.,* water, sugars, amino acids, salts; but the accessory substances and the hypothetical specific organ-forming substances of Sachs may be included in this mass; and this is suggested by the fact that on the lower side of a horizontally placed stem, roots grow out, while shoots grow out from the upper side. There must, therefore, be associated with the material which causes geotropic bending also something which favors the growth of roots and this may be one of the hypothetical substances of Sachs.

(4) These facts give a simple explanation of the "resourcefulness" of the organism referred to in the beginning of this paper, namely that plants may restore their lost apex either by the growth of the hitherto dormant buds near the wound or by a geotropic bending of former horizontal branches next to the wound (fir trees). Our experiments suggest that the cause is the same in both cases, namely, a mass action of the nutritive, and possibly also of some specific substances, upon the cells of dormant buds or upon the cells of the lower side of horizontal branches which leads to a rapid synthesis and growth in these cells. Without the removal of the old apex this growth would not have taken place, for the simple reason that the nutritive material would have had no chance to collect near the wound in masses sufficient for the growth.

(5) The phenomena of geotropism thus turn out to be phenomena of mass action, probably of the common nutritive material circulating in the sap and they are apparently of the same nature as the growth of dormant buds, which is also due to a mass action of the same substances. Gravity need play only a passive rôle, allowing masses of liquids to "seek their level." In the literature of geotropism this phenomenon is treated as a case of "stimulation," but this treatment misses the essential point, namely, the chemical mass action involved, and it substitutes a fictitious factor, the "stimulus" of gravitation, which in all probability does not exist. The case is similar to that of heliotropism when the orientation of animals to light is treated as a "reaction to a stimulus" instead of as an instance of the photochemical law of Bunsen and Roscoe.

JACQUES LOEB

THE ROCKEFELLER INSTITUTE FOR
MEDICAL RESEARCH

THE AMERICAN CHEMICAL SOCIETY

II

ORGANIC DIVISION

J. R. Bailey, *Chairman*

H. L. Fisher, *Secretary*

Some oxidation reactions: H. D. Gibbs and C. Conover. The investigation of the cause of coloration of some compounds begun some years ago by the writers while in the tropics was described. Since all of the reactions which were encountered were catalyzed by light, the studies were greatly facilitated by the intense sunlight of the tropics. These investigations are now being extended to other catalytic reactions which promise some commercial importance.

The action of aluminum chloride upon aromatic hydrocarbons: Gustav Egloff and Robert J. Moore. Benzene, toluene, xylene, cumene and cymene were distilled over a period of twenty four hours with ten per cent. by weight, of aluminum chloride in order to determine the percentage yields of reaction products. The results in terms of percentages, were as follows:

Hydrocarbons Used	Benzene	Toluene	Xylene	Cumene	Cymene
Benzene	93.4	15.0	5.6	1.5	0.8
Toluene...... . .	. .	60.0	19.0	2.7	14.3
Xylene	..	3.5	30.0	26.5	7.0
Cumene..	...		...	63.6	.
Cymene..... .	...	.	. .	.	28.5
Naphthene......	.	0.8	0.6	0.6	0.5
Tar	6.8	20.0	44.0	4.0	49.4

The naphthene formed during the above reactions proved to be hexahydrotoluene. Traces of phenol were noticed in all the reactions, the toluene, in particular, yielding one per cent.

A study of the nitrogen distribution in different soil types: C. A. Morrow. The study was made on two peats, one muck, seven mineral surface soils and one subsoil, all from Minnesota. The method of Van Slyke's protein analysis was used throughout the investigation because the nitrogen could be separated into a larger number of fractions than by the employment of earlier methods. The most significant fact brought out by this study is that the organic nitrogen distribution in *different soil types* is very uniform. This is to be expected, since the nitrogen distribution in soils is an average distribution of all the plant and animal nitrogenous products that find their way to the soil.

New derivatives of arsanilic acid: Oliver Kamm. A new series of acyl derivatives of arsanilic acid has been prepared; viz., the halogen-benzenesulfonyl derivatives, and their physiological action has been studied. The introduction of halogens increases the toxicity of these arsenic compounds.

Tetraphenylmethane: Oliver Kamm. The action of phenylmagnesium bromide upon various ethers of triphenyl carbinol has been studied. This reaction was found very convenient for the preparation of tetraphenylmethane, the yield in the case of the phenyl ether being 20 per cent.

Oxidation products of alkaline copper sulphate on lactose: W. Lee Lewis. The products are mainly galactasido acids whose hydrolysis yields galactose and acids containing from one to six carbon atoms. One hundred grams of anhydrous lactose gave 9.65 gms. of carbon dioxide, 3.06 grams of formic acid and 97 grams of nonvolatile syrupy acids. The hydrolysis of these later gave 29.30 gms. of galactose, 52.90 gms. syrupy acids and 0.486 gms. of oxalic acid. The analysis of these syrupy acids has so far yielded 14.26 gms. of mannonic lactone, 4 gms. of glycollic acid and the residue gives evidence of trioxy butyric acid and d-l glycerinic. The origin of these acids is found in the explanation of Nef. Intermediate galactasido hexose dienols are formed whose dissociation and oxidation logically account for the products. The presence of such large amounts of mannonic lactone, obtained also from maltose, must originate in a benzillic acid rearrangement of galactasido-glucosone, and sharply differentiates the oxidation of the simple hexoses from the reducing disaccharoses. The glucosido acids clearly explain the lesser reducing power of the latter.

The oxidation of ethyl alcohol by means of alkaline potassium permanganate: Wm. Lloyd Evans and Jesse E. Day. In neutral aqueous solutions of potassium permanganate at 25°, 50° and 75°, ethyl alcohol is oxidized exclusively to acetic acid; in alkaline solutions of the same reagent, acetic, oxalic and carbonic acids are the reaction products. A continuous increase in the concentration of the potassium hydroxide produces a corresponding increase in the yield of oxalic and carbonic acids, and a diminution in the yield of acetic acid. An increase in the temperature of the reaction tends to increase the yield of oxalic and carbonic acids and a diminution in the yield of acetic acid.

The oxidation of acetaldehyde by means of alkaline potassium permanganate: Wm. Lloyd Evans and Homer B. Adkins. The same general results were obtained in the oxidation of acetaldehyde in alkaline potassium permanganate solutions as are described for ethyl alcohol in the previous abstract.

DIVISION OF WATER, SEWAGE AND SANITATION

E. H. S. Bailey, *Chairman*

H. P. Corson, *Secretary*

Seasonal distribution of soil and fecal strains of the colon-aerogenes group in surface waters: **Myrtle Greenfield** and **W. N. Skourup**. A survey was made of five surface water supplies, equipped with rapid sand filters, with the object of determining the variation of the organisms of the colon-aerogenes group during wet and dry weather, and their response to treatment. During rainy weather, the soil strains of the colon-aerogenes group predominated in raw water. During extremely dry weather, fecal strains of the colon-aerogenes group predominated in raw water, particularly if there was much sewage pollution. There seemed to be no difference between soil and fecal strains isolated from raw water in their resistence to treatment.

Legal status and work of the water and sewage laboratory of the state board of health: **C. C. Young**. The laboratory was for many years dependent for support upon direct appropriation to the university by the legislature and there never were adequate funds with which to do the work demanded. The 1915 legislature passed a law requiring annual analyses and inspections of water supplies and providing for rules and regulations to be drawn up by the State Board of Health and fees to cover the cost of the work. There has been practically no objection to the law, which has been in operation since July 1, 1915. Six thousand samples were examined last year and abundant data have been collected on the operation of the purification plants of the ground-water supplies.

The problems of water supply of a great railroad system: **Orton T. Rees**. Railroads have to deal with all sorts of water conditions, dependent upon the location of their lines. As the road develops old sources of water supply become inadequate or are found harmful. Water surveys become necessary in order to secure the best possible supplies. The relatively small number of suitable waters for boiler use make it necessary to treat the greater number of waters in order to render poor water supplies suitable for boiler use. The extent of water treatment as practised by the A. T. & S. F. Ry. system. The means employed to furnish pure drinking water to the traveling public and the employes of the railroad system.

Well waters of Chicago: **Edward Bartow**. An investigation was made of the source, quality and method of obtaining the thirty million gallons of well water used each day in Chicago and the effect of removing this quantity of water. Water can be obtained from wells in the Chicago area in sufficient quantities for many manufacturing purposes. Amounts of water up to 20 gallons per minute can be obtained from wells less than 500 feet deep. For larger amounts, wells should be sunk to a depth of 1,600 feet. Salt water is reached at about 1,700 feet. Water from less than 500 feet can be used satisfactorily in boilers, but the water from the deeper wells can not be used without softening. For cooling purposes water from 350 feet having a temperature of 52° Fahrenheit and from 1,600 to 1,700 feet having a temperature of 57° Fahrenheit is available. Hydrogen sulfide is found only in water from the Niagara limestone. Water free from hydrogen sulfide can be obtained by casing off the Niagara limestone, extending the casing through the Maquoketa shale.

The vertical distribution of dissolved oxygen and the precipitation by salt water in certain tidal areas: **J. W. Sale** and **W. W. Skinner**. It was shown that the lower layers of certain tidal waters under investigation contain less dissolved oxygen than the upper layers. Evidence is presented to show that this phenomenon is caused by the stratification of the water due to the specific gravity of the under-run of sea water which cuts off vertical circulation, and to the subsequent depletion of the oxygen in the lower layers by natural agencies. The depletion of oxygen is found to be greatest in September. The precipitation and sedimentation of matter in tidal areas by sea water is presented in graphic form. Those data are considered to be of particular interest from the viewpoint of fish and shell fish life.

DIVISION OF PHARMACEUTICAL CHEMISTRY

L. F. Kebler, *Chairman*

George D. Beal, *Secretary*

The volatile oil of Monarda fistulosa: **Emerson R. Miller**. In addition to the compounds previously identified in this oil the presence of *d-a-pinene* (nitrol benzylamine, m.p. 123°–124°) has been proved and probably *butyric* and *valeric aldehydes* (p-nitrophenyl hydrazones).

The volatile oil of Nepta cataria: **Emerson R. Miller**. Two samples of this oil had the density reported by Schimmel & Company, namely 1.04. It is very different from most volatile oils in that it dissolves to the extent of 90–92 per cent. in 5 per cent. sodium carbonate solution.

The action of phenol on tin containers: HARPER F. ZOLLER. This investigation had its origin in the analysis of a precipitate occurring in the preservative used in connection with the hog-cholera serum prepared in the Serum Plant of the Kansas State Agricultural College. This preservative consisted of 5 per cent. C. P. phenol; 10 per cent. C. P. glycerol, and 85 per cent. distilled water by volume.

Some constituents of the American grape-fruit (Citrus decumana): HARPER F. ZOLLER. The object of the investigation was to determine the major constituents of the American-grown grape-fruit, and the possibilities of recovering valuable by-products from its culls. Citric acid to 75 per cent. of the amount found in lemons—an oil, similar to orange-oil, in amounts larger than in lemons, and pectin in large quantities—can be extracted from the culls in one process, as described. Glucoside can also be secured in the same process with slightly increased expense.

A laboratory method for the preparation of benzoquinone from aniline: C. E Boord and E. H. LOEB. A detailed description of a method for the oxidation of aniline to quinone by manganese dioxide and sulfuric acid. A cheaper and more convenient method for the preparation of quinone.

The preparation of a-acetyl arylhydrazines: C. E. BOORD and C. E. SENSEMANN. The preparation and properties of a-acetyl-p-tolylhydrazine, a-acetyl-o-tolylhydrazine and a-acetyl-a-(1 naphthyl)hydrazine were described in detail.

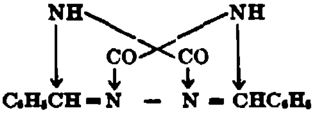
A study of the constitution of hydrazino-quinones: EDWARD SCHMIDT and C. E. BOORD. The condensation products of a-benzoyl phenylhydrazine with trichlorquinone, 2, 6-dichlorquinone and 2, 5-dichlorquinone and their derivatives are described in detail and their constitution is discussed. The evidence gained from four lines of attack seems to indicate that these substances are derivatives of orthobenzoquinone phenylhydrazone.

A further study of chloro ethers: FRIEND E. CLARK and E. MACK. Continuing the work of Clark, Cox and Mack (*J. A. C. S.*, April, 1917) the action of chloro-dimethyl ether on salts of aromatic acids has been undertaken. Methyxymethyl benzoate is a colorless liquid, boiling at 140° under 36 mm., decomposes when distilled under ordinary pressure. Molecular weight determinations and decomposition reactions indicate its formula to be

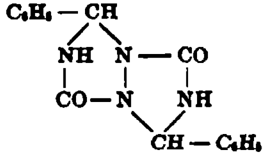
$$C6H_5COOCH_2\text{-}6\text{-}CH_3.$$

At — 35 it becomes viscous and at — 80 very viscous. Its density has been determined at 0, 18 and 25. No actions with sulphonates. Physical constants have been obtained on ethyl methyl chloro ether and chloromethylbenzyl ether is being studied.

The crisscross addition on conjugate systems: J. R. BAILEY, N. H. MOORE and A. T. MCPHERSON. This paper represents a continuation of the work of Bailey and Moore published in *Jour. Am. Chem. Soc.*, 39, 279, 1917, under the title, "The use of cyanic acid in glacial acetic acid, II., The addition of cyanic acid on benzalazine." The new work includes an investigation of the action of sulfocyanic acid and phenyl isocyanate on benzalazine, and besides the investigation has been extended to other azines. The authors interpret these reactions, as exemplified by the action of cyanic acid on benzalazine, as follows:



and suggest for this new type of reaction for a conjugate system the name, "crisscross addition." In the crisscross addition binuclear, five atom rings result. Cyanic acid and benzalazine, for example, yield,



DIVISION OF AGRICULTURAL AND FOOD CHEMISTRY

T. J. Bryan, *Chairman*

Glen. F. Mason, *Secretary*

A study of the Reichert-Meissl process with a view to its modification: A. HAYES and W. F. COOVER. Difficulty is usually experienced in obtaining closely agreeing results in determining the Reichert-Meissl number of butter fat by the present method. The authors have studied the factors which cause the variations such as method of saponification, amount of sulphuric acid used in excess, rate and temperature of distillation, shape and size of flask, temperature of condenser water and size and amount of pumice. The study has shown the influence of certain factors and that closely agreeing results can be obtained by using the proper method.

A method for estimating starch: W. S. Long. A method is proposed for the estimation of small quantities of starch in food products, and is based upon the precipitation of starch as the iodide. The method yields results of a fair degree of accuracy with weak starch solutions, and has been found applicable to the determination of small quantities of starch in jellies and jams.

The use of alfalfa flour in human nutrition: Elizabeth C. Sprague. Alfalfa flour is the finely powdered leaves of the dried plant. It contains practically no starch and is not a flour within the meaning of the term as applied to cereal flours. It can, however, be blended with cereal flours. In its unpurified state it is rank in flavor and imparts to the mixture an undesirable dark green color. A method is described by which the color is removed and the flavor materially modified. The proportions in which the purified product can be added to other flours are given. The blending of alfalfa and wheat flours increases considerably the nitrogen and the mineral contents of the preparations in which it is used. Samples were shown of breads in which the blended flour was used.

The effect of prolonged production of alfalfa on the nitrogen content of the soil: C. O. Swanson. Kansas has a number of fields in which alfalfa has been growing continuously for twenty to thirty or more years. While most of the fields are found in the middle and western part of the state, a few old fields are also found in the eastern part. Near most of these fields is found soil of the same type which has been continuously cropped to grain, usually wheat and corn, for thirty to forty years or more, and soil in native sod, used either as pasture or hay land. By sampling such fields close together and analyzing the soil, data are obtained that show the rate at which nitrogen disappears from the soil continuously cropped to grains; the nitrogen content of the soil which has never been broken; and by comparison it is possible to calculate the amount of increase or decrease in nitrogen in the soil on which alfalfa has been growing for a long time.

Variations in the ether extract of silage: L. D. Haigh. The analysis of a sample of corn silage some months after the first analysis shows that the composition of the dry matter has changed. There has been a loss in the amount of ether soluble material and crude fiber, especially the former constituent. Also the percentage of moisture and ether extract of silage at any one time will vary according to the method of drying. The acidity of silage seems to be largely the cause of change of composition on standing and the varying results on drying. The conclusions are that the corn silage should be analyzed promptly to obtain the composition of the silage as used. Also variations due to drying may be avoided by the use of the vacuum method throughout.

The occurrence and action of molds in soils: P. E. Brown and W. V. Halversen. Attention is directed to the importance from the fertility standpoint of the occurrence and action of molds in soils. These organisms have been found to occur in practically all soils, not only in a spore state, but also in an active form. In general, the numbers present have amounted to about one tenth of the total number of bacteria present. Their action is varied, but they have been definitely shown to bring about the destruction of cellulose and the breaking down of protein, producing in the latter process much ammonia. Inorganic compounds in the soil are also affected by mold growth and available phosphorus and sulfur are both produced in considerable amounts by these organisms.

Sulfofication in manures and its influence on the production of available phosphorus from floats: P. E. Brown and H. W. Warner. Mixtures of flowers of sulfur with compost, horse manure, or cow manure allowed to ferment for varying lengths of time showed a rapid oxidation of the sulfur with the production of sulfuric acid. These manures evidently possess a vigorous sulfofying flora. Rock phosphate when composted with horse manure and cow manure is reduced in availability, evidently due to an increased development of phosphorus-assimilating organisms. The reverse is true when the floats are mixed with compost. When sulfur and floats together are composted with the various manures there is an enormous increase in the production of available phosphorus, which continues up to fifteen weeks. A practical method for producing acid phosphate on the farm is suggested by composting sulfur, floats and manure in the proper proportions.

Identification of added colors in butter and oleomargarine: H. A. Lubs. The various tests for the detection of added color in butter and oleomargarine are discussed and their limitations are described. Suggestions are made for the improvement of the various tests. A method is described for the isolation of o-toluene-azo-β-naphthylamine and benzene azo-β-naphthylamine from butter and oleomargarine and a method for their identification is given.

SCIENCE

FRIDAY, AUGUST 10, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y

THE VERTEBRATE ZOOLOGIST AND NATIONAL EFFICIENCY

THE American government having been forced into the war, it is the privilege of American scientific institutions and of the army of American scientific men to adapt themselves at once to the new conditions, and to hold themselves in readiness to serve wherever their contribution is most needed.

At no time in the world's history has the necessity of thoroughgoing scientific preparation been emphasized as it is at present. For some time it has been clear that the war is a war of physics and chemistry. The pressing agricultural and medical problems of to-day make it sharply apparent that the war is no less a war of biology. Other things being equal, those national groups win which are best prepared scientifically.

A moment's consideration of certain problems, chiefly agricultural, which the war has thrown into strong relief serves to demonstrate the essentiality of knowledge of the complicated relations between man and his environment. By furnishing aggressive and intelligent leadership in this province the vertebrate zoologist can make a contribution of supreme and immediate importance to the national efficiency.

We may now proceed to discuss five propositions which stand out predominantly in this connection.

First, the possibility of the development of new resources in food or clothing is indubitable; there is no great hope for the successful elaboration of plans looking to this end, however, without intimate knowledge of the wild stock which it is proposed to domesticate or otherwise develop.

The Biological Survey has on more than one occasion called attention to the vast possibilities in wild game mammals as a source of food. Of interest in connection with the present critical shortage in the food supply of the world are the following words of Lantz[1] written in 1910:

> It is believed that with proper encouragement much of the otherwise waste land in the United States may be made to yield profitable returns from the production of venison, and that this excellent and nutritious meat, instead of being denied to 99 per cent. of the population of the country, may become a common food product.

The Honorable Franklin K. Lane, Secretary of the Interior, as reported by the daily press, recently called attention to the reindeer as a possible source of increased food supply. It has been lately suggested by J. B. Harkin, commissioner of parks for the Dominion of Canada,[2] that the barren-ground caribou, 20,000,000 strong, constitute a valuable potential meat supply. Some years ago Mr. Charles Goodnight, of Goodnight, Texas, conducted some most promising breeding experiments with the buffalo, crossing the animals principally with Polled Angus cattle, and securing fertile hybrids which ate less, put on more flesh with the same amount of food, cut more meat, and were subject to fewer diseases than the steer. Similar experiments have been carried forward by C. J. Jones, of Topeka, Kansas, and Mossom Boyd, of Bobcaygeon, Ontario, Canada, and are now being prosecuted by the Canadian Department of Agriculture. It is hoped that there may be produced an improved range animal, having 100 pounds more meat than the steer, and in addition possessing the valuable robe and rustling ability of the buffalo. The American Breeder's Association has gone on record as appreciative of the possibilities of increasing our national food supply through fuller utilization by domestication of wild birds and mammals. A recent writer in SCIENCE (Needham, April 20, 1917) wisely argues that the possibilities of undeveloped economic values in the wild species constitute an important argument for their preservation.

Second, since life is an active process, and new adaptations and adjustments are continually appearing in the complex of living things about us, man must be alert and on guard against new parasites and disease germs of one sort or another, which may be borne and distributed by animal hosts, either to valuable live stock or to man himself.

While the rôle of flies and mosquitoes as bearers of disease is well understood, that of certain mammals is not fully appreciated. In the Old World the rat is chiefly responsible for the spread of bubonic plague through its acting as host to the flea, which is the direct agent of transmission of the disease to the human being. The introduction of plague into the United States has been threatened at least once, in Seattle in 1915, and has actually occurred twice, in San Francisco in 1907–08 and in New Orleans in 1914. The most serious of these introductions took place in San Francisco and vicinity, where a part of the ground squirrel (*Citellus beecheyi*) population became infected from the rats, and threatened to disseminate the plague widely through the state. Attention has already been called to the fact that probably all kinds of rat fleas transmit plague.[3] The susceptibility to the disease of the fleas of ground squirrels suggests the possibility that the fleas of other rodents also may be potential transmitters of plague.

In addition to their plague-bearing proclivities, rats disseminate trichinosis among swine; and a note in *Nature*[4] suggests that the causative organism of epidemic jaundice, which has occurred of late on the western front in Europe, probably has its natural habitat in the rat. Examples of other mammal-borne diseases are found in the Rocky Mountain spotted fever, transmitted through the agency of ticks borne by rodents in Montana and Idaho, and rabies, carried by coyotes and dogs in Nevada and California.

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[1] Biol. Surv. Bull. 36, p. 59.

[2] *Bull. Amer. Game Prot. Assn.*, May 1, 1917, p. 8.

[3] *Biol. Surv. Bull.* 33, 1909, p. 32.

Third, the resources of nature are distinctly limited in amount, and man should know what and where these resources are, that accurate determination may be made of the amount and kind of use which may be permitted as being compatible with a regard for the rights of all the people, and of future generations.

In the matter of conservation of her natural resources America has been perhaps the most backward of all civilized peoples. She has permitted undue exploitation of all of her resources by selfish commercialism. In no province is this more apparent than in that of the wild life, where it is well known that some of the most valuable and interesting mammals and birds have been exterminated, and others dangerously reduced.

Fourth, the perpetuation of interesting and rejuvenating natural objects, including scenery, forests and wild life, demands detailed and accurate knowledge of all the objects to be preserved.

Many signs indicate that the people are coming to realize, as never before, the recreative value of the preservation of nature. The hearty support given the Department of the Interior in its epoch-making work for the national parks and that accorded the Department of Agriculture in its comprehensive forest, bird and game protective activities are full of meaning in this connection.

Fifth, a more intensive agriculture brings man into more strenuous competition with certain insect and mammalian pests; for the successful maintenance of farming and horticulture man must know both his friends and enemies in the animal world; he must be prepared to perpetuate beneficial species, and he must be ready to control or exterminate those which are detrimental.

Disturbance of the balance of nature, having to do with increased competition between man and certain pests, is effected in several ways, of which the following are important: Destruction of carnivorous or predatory birds and mammals; reduction in numbers of game birds and mammals; introduction of useful domesticated species of plants and animals; involuntary or mistaken introduction of harmful exotic species of plants and animals; cultivation of the soil and the raising of crops; removal of the natural cover of forest and brush.

Some of these disturbing factors, notably the increase in the supply of rodent food provided by growing crops, and, all too often, the ill-advised destruction of natural checks on rodent increase, such as hawks, owls, badgers, skunks, weasels and other predatory animals, indicate that rodent outbreaks may be expected to occur more frequently in the future than they have in the past, and it is well known that plagues of rodents have harassed mankind at intervals since the dawn of history.

In Nevada in 1907 and 1908 meadow mice of the genus *Microtus* overran four fifths of the cultivated area in the lower Humboldt valley leaving a "dismal scene of destruction," and necessitating the complete replanting of much alfalfa land.[5] Depredations of cotton rats (*Sigmodon*) in certain sections of the middle west, notably southern Kansas and Oklahoma, in the spring of 1915–16, were so severe that in some instances no less than three plantings of corn had to be made.[6] A serious outbreak occurred during 1916 in the province of Foggia in Apulia, Italy,[7] where the grain crop is reported to have been almost entirely destroyed by inordinate increase of voles of the genus *Pitymys;* and in the fertile Shenandoah valley, Virginia, where a thriving fruit industry is conducted, mice belonging to the same genus have become so abundant and so troublesome during the spring of 1917 that in some orchards they have girdled and killed seventy-five per cent. of the trees.[7]

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[4] January 18, 1917, p. 393.

[5] Piper, Yearbook, U. S. Department of Agriculture for 1908, 1909, p. 302.

That the steady drain upon our agricultural products caused by various noxious rodents over a large part of the country when present in normal numbers is of even greater consequence to our agricultural welfare than the damage from plagues has already been emphasized by Lantz.[8] Some idea of the extent of this damage may be gained from the following figures, gathered recently by the chief of the Biological Survey.

The annual loss to grain crops through the agency of ground squirrels in North Dakota on the basis of present prices is estimated by authorities at the State Experiment Station to aggregate more than $6,000,000.

A. E. Bowman, director of the State Agricultural Extension Service, Wyoming, states that 15 per cent. of the crops within that state are destroyed annually by rodents.

The annual losses from rodents in the state of Kansas are placed at $12,000,000.

The department of biology of the Montana Agricultural College estimates that the crops in that state suffer annual losses through ravages of rodents amounting to $15,000,000 to $20,000,000.

These are isolated reports concerning a situation which is general; a conservative estimate places the probable losses to agriculture from noxious native rodents in the western and Pacific states alone at more than $100,000,000 annually.

In 1909 fire losses and losses to grains and other merchandise due to European rats and mice were estimated to aggregate $59,917,000 annually.[9] Assuming that the amount of damage done by these rodents is approximately the same now as then, it is not improbable, at present prices of grain and other merchandise, that the annual losses will aggregate at least $100,000,000. Suggestions made by Creel[10] and Forbush[11] indicate that even this figure may be far too low. The former estimates that each rat costs one half a cent per day, or $1.82 per year, to feed; and the latter calls attention to the fact that on the basis of Creel's estimate, assuming that the rat population is the same as the human population, the annual cost to the country is $182,000,000; and both these suggestions were made when the price of wheat was less than half what it is at present.

The cogency of these facts is more than ever apparent during the present growing season. Weather conditions have been unfavorable, labor is scarce and the winter wheat crop is reported to be the shortest in years. All practicable steps should be taken, not only to increase acreage, but to guard against local or general plagues of insects or rodents, and to cut down to the minimum the enormous losses which heretofore have occurred continuously. The saving of grain which will be effected through up-to-date and aggressive methods of rodent control will furnish an increased food supply for America and her Allies which will help to guarantee just that margin of advantage in the world struggle which will be necessary to victory.

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[6] Reported by Professor D. E. Lantz, Biological Survey.

[7] *Nature*, December 28, 1916, p. 338.

[8] *Biol. Surv. Bull.* 31, 1907, p. 8.

[9] C. Hart Merriam, Rept. Nat. Conservation Commission, Vol. 3, pp. 339–340.

[10] U. S. Public Health Reports, 28, 1913, p. 1405.

[11] Bull. No. 1, Econ. Biol., Mass. Board of Agriculture, 1915, p. 25.

Essential to action regarding any of the problems discussed in this paper, whether the domestication of and development of new resources from wild stocks, the protection or propagation of those which are beneficial, or the control or destruction of detrimental species, is an intimate and accurate knowledge of nature. And this knowledge can only come, in any comprehensive and authoritative way, through the collection of series of specimens, with the associated study, in field and laboratory, of the distribution, systematic relationships, habits, economic status and ecology of the animals concerned.

The present-day organization of American science delegates this task to the vertebrate zoologist in college or university, museum of natural history, or government laboratory.

It should ever be the obligation of the scientific man to labor for the public good. With a world to help feed, and a war to help win, it now becomes peculiarly the duty and privilege of the American scientific man to make increased practical application of technical information, in short, to furnish a large measure of cooperation and leadership in the struggle to make democracy efficient and so to secure the benefits of government by the people for the nations of to-day and the generations of the future.

WALTER P. TAYLOR

BIOLOGICAL SURVEY

THE STATUS OF THE GRADUATE DEGREE IN MEDICINE[1]

THE University of Minnesota is offering graduate work in the various fields of medicine and surgery in three-year courses open to students who already possess the bachelor's degree, or its equivalent, the doctor's degree in medicine from a Class "A" medical school, and who have had at least one year's internship in a general hospital or a year's service in an approved laboratory of the medical sciences. On the satisfactory completion of such a three-year course, the student is eligible for the degree of Doctor of Science in internal medicine, in surgery, in pathology, or in whatsoever other branch of medicine he may have chosen his major subject.

The status of this new degree of Doctor of Science in a medical specialty has not yet been determined; hence the following analysis and discussion. Since the conditions laid down regarding admission, residence, language requirements, thesis and examinations are those which have long been applied by graduate schools of universities in the approval of candidates for the degrees of Doctor of Philosophy or Doctor of Science, it has been assumed by some that the new degree in medicine scholastically reaches only the level of these older degrees. This assumption would seem to be incorrect, first because of the longer time required to obtain the degree, and, second, because of the scientific ability exhibited by men with only the formal schooling represented by the doctorate in medicine or the baccalaureate in arts or sciences.

In the following diagram is shown the relationship in point of time required for the attainment of the M.D. degree in schools with the "Minnesota standard" and the attainment of the Ph.D. degree in universities in general, as well as the additional time required for the attainment of the new degree of Doctor of Science in a medical specialty.

It will be noted from the diagram that four students, *A*, *B*, *C* and *D*, who have had the necessary high-school or other preparatory training, enter the college of literature, science and the arts of the university at the same time and pursue regularly prescribed courses. At the end of two years in college, during which time he has taken a preponderance of prescribed physical, chemical and biological studies, *A* transfers to the medical school, and

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[1] Presented before the Minnesota Academy of Medicine, St. Paul, Minnesota, October 11, 1916.

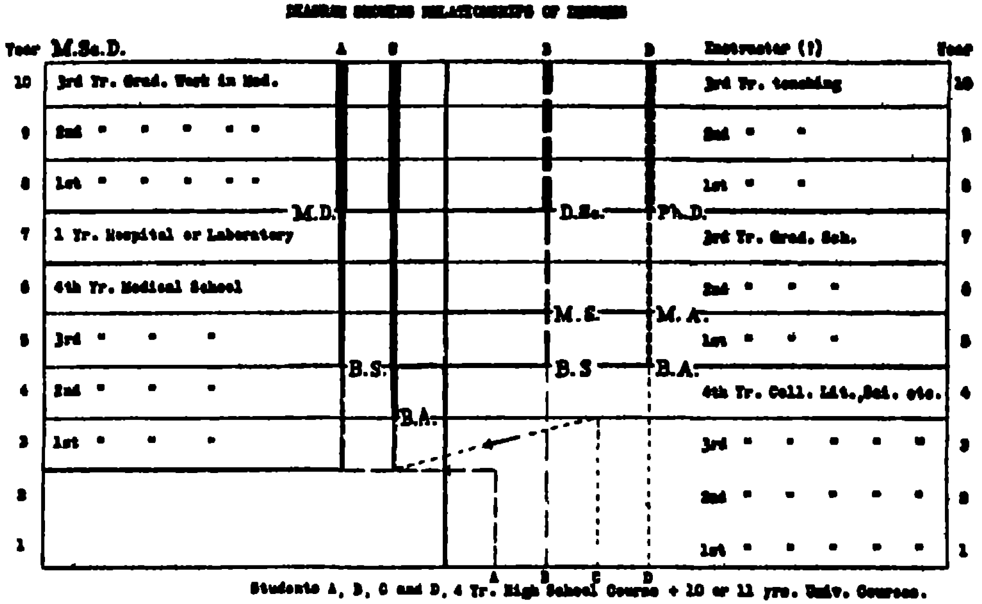

Diagram showing Relationships of Degrees
Students *A*, *B*, *C* and *D*, 4-year high-school course + 10 or 11 yrs. university courses.

takes therein two years more work, at the end of which time—a total period of four years—he receives his B.S. degree. *B*, taking a preponderance of prescribed physical, chemical and biological sciences, at the end of four years, all spent in the college, also receives his B.S. degree. *C*, entering the same college, but in addition to the required physical, chemical and biological sciences, adding thereto the special study of literature and the arts, at the end of three years in the college transfers to the medical school and in one year more, or after a total period of four years, receives his A.B. degree. *D*, entering the college and not indulging in a preponderance of the physical, chemical and biological sciences, but giving special attention to literature and the arts, receives his A.B. degree at the end of four years. Thus, each receives a bachelor's degree at the end of four years. If all four continue in the schools in which they were working at the time they received their bachelor's degree, *B* and *D* will receive their master's degrees at the end of another year and their doctorate degrees in science and philosophy, respectively, at the end of three years. Similarly *A* and *C*, after two and three more years respectively in the medical school and one year in an approved hospital or laboratory, will receive their doctor's degrees in medicine. Therefore at the end of seven years in the cases of *A*, *B* and *D*, and of eight years in the case of *C*, all four have attained the doctorate degree. It would appear that men starting on the new three-year graduate courses in medicine offered by the University of Minnesota in the clinics and laboratories in the Medical School in Minneapolis and in the Mayo Foundation in Rochester, already have spent as much time in making their approach to the study of medical specialties as that required for obtaining the Ph.D. or D.Sc. degree in good institutions.

It is improbable that the native ability, the preparatory school instruction, the habits of study or the skill of their university instructors, in the long run, is either better or worse in the group of doctors of medicine than in that of doctors of philosophy or science. Yet all will agree that, broadly speaking, there is a difference in the scientific attitude and habits of thought in the men of the three groups. This difference is best explained by the fact that of the four students whose scholastic careers have been diagramed above, *B* and *D* have usually placed most intensive study on a very small field of science or art, while *A* and *C* have given less intensive study to a relatively much broader field. Incidentally also, *A* and *C* are apt to have come more closely in contact with living conditions, with science in the making as it were, than have *B* and *D*. The question is open to discussion whether *B* and *D* may not have concentrated too early and may not later suffer from lack of a broad knowledge of the science in the narrow field in which they have specialized and of other sciences related thereto. Some of the possibilities in this respect are pointed out by Stephen Leacock in one of his delightful "Essays and Literary Studies." Be this as it may, certainly *A* and *C* at least should be well able to see the broader relationship of narrow lines of scientific investigation. The question of present concern, however, is not the breadth of their culture—which unfortunately is usually all too narrow to enable them to get the most real enjoyment out of life—but rather the amount of their scientific ability, *i. e.*, their ability to utilize in new ways old scientific truths and to discover, as well as to utilize, new scientific truths.

TABLE I

Analysis of Scholastic Degrees of Members of Certain Clinical Medical Societies

Name of Society	Total Number Members Whose Degrees Were Found	Percentages.			
		Total M D	M D Only	M.D. and A B or Equiv.	M D. and Ph D.
American Surgical Association	169	100	55	43	2
Association of American Physicians	147	100	32	63	5
American Orthopedic Association	116	100	62	37	1
American Association of Obstetricians and Gynecologists	167	100	73	24	3
American Pediatric Society	66	100	30	67	3
American Laryngological, Rhinological and Otological Society	196	100	66	33	1
Totals	861	100	56	42	2

The estimation of the relative scientific ability of members of the various groups is very difficult. Even if we could measure accurately each individual's scientific accomplishments we still might be in the dark concerning his native ability or the amount of his premedical and graduate study not represented by formal schooling. But in comparing large groups these factors may fairly be assumed to approximately cancel each other.

Turning then to the question in hand—namely, the relative scientific ability of men who have ended their schooling with the attainment of the M.D. degree as compared with those who have obtained the Ph.D. degree, we may, I think, start with the premise that medical science in America has at least kept abreast with any other science during the last quarter of a century. We might indeed be within the truth in saying that it has led in development, but for the purpose of the present essay, it is but necessary to assume that it has been equal to any other. The second premise, which we may lay down without question, is that the progress in medical sciences has been made by the men who are in the medical profession. It may further be postulated that in the United States most of the men who are responsible for the progress of medical science are members of the various medical societies whose membership is limited to those who have attained some distinction in some special field of medicine. It is presumable that there are instances of general practitioners who are not members of any society of the kind herein analyzed, and who yet have added materially not only to the practise, but also to the science of medicine. Such individuals, however, must be so few that their omission would have relatively little to do with the figures or the question in hand. I have, therefore, taken the membership lists of the various medical specialists' societies in the United States of which the data were obtainable, and have analyzed the scholastic attainments of the members as a matter of comparison. Elimination of duplicate memberships has not been attempted since it would have been both difficult and unfair.

The results of the analysis of the scholastic degrees of certain clinical medical societies of limited membership are shown in Table I.

TABLE II

Analysis of Scholastic Degrees of Members of Societies Covering the Fundamental Medical Sciences

Name of Society	Total Numbers Whose Degrees Were Found	Percentages					
		Total M.D	M D. Only	M D. and A B. or Equiv	M.D. and Ph.D	Ph.D.	Other Degrees
American Association of Anatomists..	283	64	28	36	4	24	12
American Physiological Society	223	54	26	18	10	37	8
American Society of Biological Chemistry	153	41	13	16	12	50	9
American Bacteriologists	335	47	24	20	3	23	30
American Association of Pathologists and Bacteriologists	316	95	40	52	3	2	3
American Society for Experimental Pathology..	40	100	30	60	10	0	0
American Society for Pharmacology and Experimental Therapeutics..	74	87	49	26	12	13	0
American Society of Experimental Biology and Medicine	283	68	24	38	6	28	4
American Psychopathological Association	44	84	39	36	9	16	0
American Association for Cancer Research	89	94	40	49	4	3	2
Total....	1,840	68	28	34	6	22	10
Compare with Analysis of Certain Clinical Medical Societies (Table I.)	861	100	56	42	2	0	0
			73				
"Who's Who in America" (1915 edition, selected names of those engaged in physical, chemical or biological sciences).	3,446	48	20	26	2	23	29

Membership in these clinical medical societies presupposes the possession of the M.D. degree. It is interesting to note that, taken as a whole, 56 per cent. of the 861 members have the M.D. degree only, while 44 per cent. have the M.D. with some other earned degree. It is also interesting to note that only 2 per cent. of the 861 members have the Ph.D. degree in addition to the M.D. degree.

An analysis of the scholastic degrees of the societies covering the fundamental medical sciences is shown in Table II. In these, the possession of the M.D. degree is not obligatory for membership. Of the total 1,840 members 68 per cent. have the M.D. degree, 28 per cent. the M.D. only, 34 per cent. the M.D. with the bachelor's degree, 6 per cent. the M.D. and the Ph.D., 22 per cent. the Ph.D. without the M.D. and 10 per cent. neither the M.D. nor the Ph.D. The percentage of those having the M.D. without the Ph.D. (62) is nearly three times that of those having the Ph.D. without the M.D. (22). When to the number of these members is added the number of men having similar attainments who are members of the clinical medical societies, we find that 78 per cent. of the total 2,701 have the M.D. degree, or the M.D. with the A.B. degree or its equivalent. Thus, it would seem that 78 per cent. of the men who have been responsible for the progress of American medicine started with only the scholastic equipment, at least so far as is indicated by their degrees, of the men now entering upon the study of specialties in medicine, while only 15 per cent. have the Ph.D. or B.Sc. degree.

Probably one third of the 2,701 members of the medical societies here studied are duplicates. In order to get a larger list and at the same time cover a broader field I have made for comparison a similar analysis of the earned degrees of 3,446 persons engaged in any of the physical, chemical or biological sciences (including medicine), whose names appear in the 1915 edition of "Who's Who in America." The inclusion of a name in this publication indicates that its holder has attained a certain amount of public eminence though not necessarily of a kind indicated by his degree. An analysis of the degrees of these 3,446 persons shows that 48 per cent. have the M.D. degree, 20 per cent. have the M.D. only, 26 per cent. have the M.D. plus the A.B. or its equivalent, 2 per cent. have the M.D. plus the Ph.D., 23 per cent. have the Ph.D. without the M.D. and 29 per cent. have degrees other than M.D. or Ph.D. It therefore appears that in the field of physical, chemical and biological sciences the sort of eminence indicated by registry in "Who's Who" has been attained by twice as many with the degree of M.D. as with the degree of Ph.D.

An analysis of similarly selected names in "American Men of Science" was begun but abandoned since it was found that the latest (1910) edition does not include the names of many of the younger men who are largely responsible for the present progress of American medicine.

Until the later years of the last century the teaching of medicine in America, except in a very few schools, was a travesty on pedagogy. During the present century it has probably improved more than the teaching of any other science. To-day the man who obtains the M.D. degree from an institution with the equivalent of the "Minnesota standard," *i. e.*, including a final year's hospital or laboratory work, probably has quite as much scientific ability as the man who obtains the Ph.D. or D.Sc. degree from the same institution. This seems to be proved by the time he must study, by the character of the subject-matter of his studies, and by the probability of his accomplishing something in science in after life. If this be true and the M.D., Ph.D. and D.Sc. degrees from high-grade institutions represent an equivalent training, it must then appear that the three years of graduate training in a special branch of medicine now offered by the University of Minnesota should result in scientific ability just three years "to the good" of that represented by any one of the three doctorate degrees.

Louis B. Wilson

Mayo Clinic,
Rochester, Minn.

SCIENTIFIC EVENTS

THE RESEARCH CORPORATION

The Research Corporation was incorporated in the State of New York in 1912 on the initiative of Dr. F. G. Cottrell, who gave to it his patents concerning the process known as the "electrical precipitation of suspended particles." The objects of the corporation are:

> First: To build up a business organization which, so far as possible, should be a model of efficient administration, for the purpose of demonstrating the commercial value of the precipitation processes included in the original gift and of such other inventions as the corporation might acquire by gift or otherwise, and of making such inventions a source of profit.
>
> Second: From the profits so earned to accumulate an endowment fund to be used for the intensive study of scientific and industrial needs, and to provide the means, through the testing of new discoveries and through study, investigation and experimentation, of supplying such needs.

During the year 1916 the pioneer period in the application and development of the electrical precipitation processes may be said to have been completed. The corporation, which began with a cash capital of ten thousand dollars, is now spending that amount every month and has in its service a staff of forty-five engineers and others engaged in field and office work. The assets of the corporation as reported by the auditors on February 16, 1917, in cash and securities, were $217,862.72. A laboratory has been established and experts have been employed to study the workings of the precipitation processes, and, if possible, to develop improvements and meet new problems. Careful consideration has also been given to other patents and processes which have been offered to the corporation, and although none have as yet been accepted, it is the purpose of the corporation to lend its aid to the utilization of any invention or discovery which offers sufficient promise of promoting the application of scientific discovery to the industrial arts.

For the purpose of encouraging scientific research directed to the development of the industrial arts the research corporation offers a fellowship of the annual value of $2,500, to be awarded on competition under the following conditions:

1. The competition will consist of the submission of evidence of scientific attainments, discoveries or inventions, and of special fitness for advanced work.

2. All persons desiring to compete must fill in a form of application, which will be furnished by the secretary of the corporation upon request, and file the same on or before October 1, 1917, together with such letters of reference, scientific publications and other documents or evidence as they may desire to submit, including a specific statement of the particular field or object of the research or investigation which the competitor proposes to conduct and a pledge that he will devote himself faithfully to the prosecution of such research or investigation if awarded the fellowship.

3. The competition shall be decided on or before December 1, 1917, by a jury consisting of the president of the National Academy of Sciences, the secretary of the Smithsonian Institution, the presidents of the American Chemical Society and Research Corporation, respectively, and the chairman of the Engineering Foundation, or such persons as they may respectively designate to act for them.

4. The term of the fellowship shall be one year from the date of the award, but the term may be extended by the corporation for two renewals of one year each in exceptional cases upon the recommendation of the jury.

5. The stipend of each fellowship will be paid as follows: $300 on the award of the fellowship and $200 monthly thereafter for the remainder of the year.

6. Fellows will be required to report in writing at the office of the corporation within twenty days from the date of the award (unless the time shall be extended) and to begin their research or investigation at once. In case of their failure to do so, or in case they shall fail to prosecute the same with proper attention, the fellowship may be terminated by the corporation.

7. Any fellow who shall resign or retire before the conclusion of the term of his appointment, or who shall be dismissed by the directors of the corporation for cause, will forfeit all privileges and emoluments of his fellowship and have no claim to the further payment of his stipend.

8. The corporation will endeavor to secure for fellows the privileges of laboratories specially adapted for their particular work.

9. Each fellow shall make a written report to the corporation at the conclusion of his appointment of the results of the research or investigation which he has conducted. Any discovery or invention which he may make shall be deemed his personal property.

ANTHRACITE COAL MINED IN 1916

The anthracite mined in 1916 amounted to 78,195,083 gross tons, valued at $202,009,561, a decrease in quantity of 1.6 per cent. and an increase in value of 9.4 per cent. compared with 1915. The shipments decreased 1.7 per cent.—from 68,666,456 gross tons in 1915 to 67,501,363 tons in 1916. The shipments of prepared coal of sizes above pea in 1916 were 40,747,215 tons, a decrease of 1.1 per cent.; the shipments of pea size were 7,520,804 tons, a decrease of 8.4 per cent.; and the shipments of steam sizes smaller than pea were 19,233,344 tons, a decrease of but .05 per cent. compared with 1915. There was an increase of nearly 6 per cent. in the quantity of anthracite sold locally and used by employees and a decrease of 2.4 per cent. in the quantity used for mine fuel. The compilation of these statistics has just been completed by C. E. Lesher, of the United States Geological Survey, Department of the Interior.

The effect of the extraordinary demand for steam sizes of anthracite that followed the industrial activity in 1916 and the high price of bituminous coal is indicated in the figures showing the output of washery product and dredge coal. Although the freshly mined coal in the anthracite region, including Sullivan County, showed a decrease of 2.6 per cent. in 1916 compared with 1915 there was an increase of 19.6 per cent. in the quantity of anthracite obtained from the washeries, which operate mainly on old culm banks, and an increase of 16 per cent. in the quantity of coal dredged from rivers.

The production in the Lehigh region was 10,929,055 gross tons; in the Schuylkill region, 23,659,448 tons; in the Wyoming region, 43,111,782 tons; and in Sullivan County (Bernice Basin), 494,848 tons.

There was a large decrease in the number of men employed in the production of anthracite in 1916, and the output was maintained only through an increase in the number of working days. The number of men employed in 1914 was 179,679; in 1915, 176,552; and in 1916, 159,869. The average number of days worked was 245 in 1914, 230 in 1915, and 253 in 1916. The average output per man per day in 1914 was 1.84 gross tons; in 1915, 1.96 tons, and in 1916, 1.93 tons. The average output per employee for the year was 451 tons in 1914; 450 tons in 1915; and 489 tons in 1916.

ANIMAL COLLECTIONS FROM AUSTRALIA

The animal collections of the Zoological Park have been enriched by the arrival of another great "caravan" from Australia. After six months of diligent effort, and generous expenditures of money, Mr. Ellis S. Joseph brought together and successfully transported to New York the largest collection of rare species of mammals, birds and reptiles that ever came to America. The common species, such as for years have been coming to us through the regular European channels, are conspicuous by their well-nigh complete absence.

Naturally, the officers of the Zoological Society feel measurably elated over this coup, at a period of great depression in the wild-animal supply from other sources. The receipts from England are very trifling, and from the continent of Europe nothing whatever comes. In fact, in America the German wild-animal business is thoroughly dead. Our further operations in South Africa must be postponed until after the war.

Encouraged through his previous reception by the Zoological Society, Mr. Joseph redoubled his former efforts to bring to America something worth while. The collection which he landed in Victoria, B. C., a month ago represents a large outlay in money and effort, and great scientific value. Of that importation the Zoological Society has purchased mammals, birds and reptiles to a total cost of about $6,000. The Philadelphia Zoological Society has purchased $3,000 worth, and other purchases are proceeding.

The following list shows the newly acquired mammals:

1 thylacine,
3 hyraxes,
2 water mongooses,
1 echidna,
2 rabbit-eared bandicoots,
2 West Australian rat kangaroos,
1 tree kangaroo,
3 yellow-footed rock wallabies,
2 Woodward kangaroos and young,
1 wallaroo,
1 brush-tailed wallaby,
2 short-tailed wallabies,
1 Paddy Mellen wallaby,
2 rufus-necked wallabies,
2 Tasmanian black phalangers,
6 spotted phalangers,
3 dusky phalangers,
3 gray phalangers,
3 Papuan phalangers,
1 Australian phalanger,
4 marsupial mice,
3 Australian water rats.

The majority of our accessions will be found in the large bird house, the small deer house, the reptile house and the small mammal house, but the thylacine is in one of the small bear dens. Each new species is marked by a red label reading "Recent Accession." Incidentally it is to be noted that our total kangaroo collection is believed by Mr. Joseph to be the most extensive series ever brought together. It will be found in the small deer house.

W. T. Hornaday,
Director

SCIENTIFIC NOTES AND NEWS

Professor Milo S. Ketchum, dean of the College of Engineering of the University of Colorado, was elected president of the Society for the Promotion of Engineering Education at the annual meeting of the society held recently at Washington.

MAJOR PEARCE BAILEY, M.R.C., chairman of the committee on furnishing hospital units for nervous and mental disorders to the United States Government, has been asked by the Surgeon-General to serve as adviser in all matters pertaining to psychiatry and neurology.

The Electrical World states that Brigadier General George O. Squier, U. S. A., chief signal officer of the army, has been made a fellow of the Royal Society of England in recognition of his invention of a new system of ocean cabling which, it is believed, will be of the greatest service in the war.

DR. CHARLES J. BARTLETT, New Haven, director of the pathologic laboratory, Yale University, has been appointed director of the bureau of laboratories of the state department of health, succeeding the late Professor Herbert W. Conn. P. E. Bransfield, Ira D. Joel, Ira V. Hiscock and George E. Stookey, who were assistants to Professor Conn, have been appointed to similar positions by the new director. It has been decided to remove the laboratory from Middlebury to the Agricultural Experiment Station, New Haven.

DR. SOCA, professor at the University of Montevideo, former president of the republic of Uruguay, and Dr. Couto, professor of internal medicine at the Faculté de Rio-de-Janeiro, the former president of the Academy of Medicine of Brazil, have been elected members of the Paris Academy of Medicine.

THE Russian Geographical Society at its annual meeting elected as honorary members Mr. Douglas Freshfield and Sir Aurel Stein, and as corresponding members Sir Ernest Shackleton and Mr. G. G. Chisholm.

ONE hundred Japanese physicians are said to be on the way to Roumania in charge of Dr. Motegi, chief of the Saiseikai Hospital and head of the surgical department of the Keio University.

DR. OLIVER FASSIG has gone to San Juan on a special mission to extend and reorganize the Weather Bureau service in the West Indies. In the Virgin Islands a station is to be established, two stations are to be started in Haiti and one at Puerto Plata, Santo Domingo. The station in San Juan will probably be designated as the station in charge of the West Indies Service.

PROFESSOR E. W. GUDGER, of the State Normal College, Greensboro, N. C., spent June and July at the American Museum of Natural History, in work on the "Bibliography of Fishes," of which Professor Bashford Dean and Dr. C. R. Eastman are editors.

DR. BURTON J. LEMON, formerly instructor in the department of chemistry of Cornell University, and during the last two years a chemist with the United States Rubber Company in New York, has received a commission as captain in the Quartermaster Officers' Reserve Corps.

DR. H. B. NORTH has recently resigned his professorship in chemistry in Rutgers College in order to become director of the research laboratories of the York Metal Alloy Co., of York, Pa.

CHARLES H. TUCK, professor of extension teaching in the New York State College of Agriculture, Cornell University since 1910, has resigned from the faculty. He has been absent on leave since January, 1916, when he went to Manchuria, and he is still there, engaged in agricultural investigations for an American syndicate. Maurice C. Burritt, extension professor and state director of farm bureaus in the college, has been elected to succeed Professor Tuck.

O. C. CHARLTON, until recently a teacher of biology, has been appointed city forester for Dallas, Texas.

DR. LEON I. SHAW, of Northwestern University, has been advanced to the position of assistant professor of chemistry on leave of absence of one year for service with the United States government. He has received the appointment of first lieutenant of the Ordnance Officers' Reserve Corps.

ACCORDING to the *Cornell Alumni Bulletin*, G. Harold Powell, general manager of the

California Fruit Growers' Exchange, has accepted an invitation from Herbert C. Hoover, to take charge of the distribution of all perishable goods in the United States. Mr. Powell is now in Washington. For many years he has made his specialty the study of the problems of food storage and transportation. From 1901 till 1911 he was in the bureau of plant industry of the U. S. Department of Agriculture.

DR. A. J. CARLSON, professor of physiology in the University of Chicago, recently delivered an address on "The recent advances in the physiology and pathology of the alimentary tract," before the faculty and students of the graduate summer quarter in medicine of the University of Illinois.

PROFESSOR ALBERT FREDERICK GANZ, of the Stevens Institute of Technology, known for his investigations on electricity, died by suicide on July 27, aged forty-five years.

DR. L. E. RUSSELL, formerly president of the American Medical Association, a physician and surgeon known nationally, died suddenly at his home in Springfield, Ohio, on August 2, aged sixty-six years.

WILLIAM WALLACE TOOKER, an authority on Indian nomenclature and archeology, died on August 1, after a long illness at his home in Sag Harbor, L. I., at the age of sixty-nine years.

DR. ROBERT BELL, F.R.S., formerly chief geologist of the Geological Survey of Canada, has died at the age of seventy-six years.

EDWARD STANFORD, F.R.G.S. (son of the founder of Edward Stanford, Limited, London, cartographers to the king) a well-known publisher and geographer of London, died on June 6. His life was one of continued activity in advancing the science of geography and map-making. He had charge of all the ordnance maps of the United Kingdom, and issued numerous atlases, monographs, and maps of all the countries of the world.

WE learn from *Nature* of the death of Professor K. R. Birkeland, of Christiania, which occurred in Tokyo on June 18. Professor Birkeland was largely interested in the extraction of nitrogen from the atmosphere and other industrial work, and is known to scientific men for his observation and theories on cosmical phenomena.

THE Fourth Annual Conference of the Society for Practical Astronomy will be held August 16, 17 and 18, at the University of Chicago. Professor F. R. Moulton, of the university, and Professor W. D. MacMillan will lecture at the sessions and there will be papers presented by other members of the society. The sessions are open to the public, and visitors from other cities, whether members of the society or not, are invited to attend.

SURGEON GENERAL GORGAS has issued a statement that medical students are not to be exempt from draft, but will be given conditional and limited furloughs to continue their medical studies. This furlough is intended to furnish an opportunity for the student to complete his studies and obtain his required year of hospital experience, so as to fit him for service in the medical department of the army. The Surgeon General, through the medical section of the Council of National Defense, is endeavoring to prevent the undue depletion of the civilian hospital staffs for service at the front.

A BILL has been introduced into the House of Representatives, providing that there shall be established one additional division each of mental hygiene and rural sanitation in the United States Public Health Service, and said divisions shall be in charge of commissioned medical officers of the United States Public Health Service, detailed by the Surgeon General, which officers, while thus serving, shall be assistant surgeons general within the meaning of section three of the act approved July 1, 1902, entitled "An act to increase the efficiency and change the name of the United States Marine Hospital Service." Sec. 2. That the duties of the division of mental hygiene shall be to study and investigate mental disorders and their causes, care and prevention. The duty of the division of rural sanitation shall be to investigate improved methods of rural sanitation, and the prevention and suppression of communicable diseases.

The *Journal* of the American Medical Association states that the Academy of Medicine of Toronto has adopted a resolution calling for one united medical service in Canada to take the place of the present arrangements of a Canadian Army Medical Corps and a Canadian Hospitals Commission. The academy urges that medical care of all soldiers be placed directly under a surgeon general, to be known as Surgeon General of Canada, who should be directly responsible to the minister of militia, who should have a seat in the militia council. He will perform the duties of director of medical services, invalids and be chief medical officer of the hospitals commission and of its executive. The academy recommended Surgeon-General John Taylor Fotheringham, C.M.G., Toronto, recently returned from overseas, for this position.

The emperor of Austria, according to the *Journal* of the American Medical Association, has organized a new state department, the chief of which is to be known as the minister of hygiene and social welfare.

The yacht *Anton Dohrn,* of the department of marine biology of the Carnegie Institution of Washington, has been offered to and accepted by the United States Navy for the period of the war.

The board of managers of the New York Botanical Garden announces plans to expend $500,000 in developing the garden. Three of the largest works projected are the construction of a museum laboratory wing which will cost $100,000, the building of a wing to the east museum to cost $100,000, and a central display greenhouse to cost $75,000. An orchid greenhouse will cost $24,000, and a like sum will be spent in building an economic plant greenhouse. Two tropic plant greenhouses, a garden school greenhouse, experimental and investigation greenhouses also are to be constructed. In a report of the garden's endowment committee it is announced that a contribution of $2,000 has been made by Mrs. Robert E. Westcott for the construction of the new rose garden stone stairway, and a gift of $4,000 has been made by Mrs. Frederick F. Thompson for the construction of the school garden shelter on the eastern bank of the Long Lake at the southern end of the new school garden.

The fourth meeting of the Conjoint Board of Scientific Societies of Great Britain was held on June 13 at the Royal Society, with Sir J. J. Thomson, F.R.S., in the chair. The report of the executive committee for the past half year showed that a number of questions of scientific and industrial importance have come before the board. Among these are the need for an anthropological survey of the British people, the maintenance of the international catalogue of scientific literature and the desirability or otherwise of adopting the metric system throughout the British Isles.

An opportunity for research work in sociology with some time for other graduate work if desired awaits a suitable applicant at the University of Chicago and for this $1,200 has been set aside for each of the two years it is expected the investigation will require. By this announcement it is hoped to secure some one already specializing in sociology. Inquiry for further details may be addressed to Professor Albion W. Small, University of Chicago, or to Dr. E. R. LeCount, Rush Medical College, Chicago.

The Bureau of Economic Geology of the University of Texas has just issued a report on the Thrall Oil Field by J. A. Udden, H. P. Bybee, E. P. Schoch and W. T. Read. This field was discovered three years ago, in Williamson County, and it proves to be unique for the United States, the greater part of the production coming from a metamorphic chlorite derived from an extremely basic igneous rock. This rock apparently represents a submarine eruption in the Cretaceous sea.

The *Medical Record* states that the Rockefeller Institute for Medical Research, through the research work of Dr. Carroll G. Bull and Miss Ida W. Pritchett, will undertake to supply the allied armies with a serum which is believed to be an effective antitoxin for the gas bacillus producing gangrene. Cultures of the gangrene bacillus were obtained in Europe last year and these investigators have experimented upon animals and produced the hoped-for results.

UNDER the direction of Dr. Roger Adams, of the division of organic chemistry of the University of Illinois, a group of graduate students is engaged in preparing chemicals that are being sold to as many as fifteen different university laboratories, to the Bureau of Chemistry at Washington, to large distributing houses, and commercial firms. One chemical, for which there has been a shortage ever since the work began, is now being supplied from this laboratory in sufficient quantities to meet all demands of the country.

THE annual meeting of the Incorporated Society for Extending the Rothamsted Experiments in Agricultural Science was held on November 6. According to the report in the London *Times* Lord Crawford, president of the British Board of Agriculture, moved a resolution declaring that the work of the society was a matter of national importance deserving wide public support. He said that much would be expected from agriculture after the war, and much more, therefore, would have to be drawn from the knowledge, experience and guidance of such societies as that of Rothamsted. It would be really deplorable if any single branch of its activity had to be dropped during the war. It was at Rothamsted that the first practical demonstration of the value of artificial manures was consummated. He was fully conscious of the urgent necessity for the comprehensive treatment of this great subject, but the time was not yet ripe for any public announcement. Meanwhile, he trusted that the work of Rothamsted would continue and, in spite of the war, extend in the sphere and scale of its operations. In any future scheme he was certain that Rothamsted would take a high and honorable place, and would contribute to the research which was essential to the future of British agriculture. Dr. E. J. Russell, the honorable secretary and director of the Rothamsted Station, stated that the ordinary work at Rothamsted had been curtailed, but it was not being allowed to drop. Women had been brought in, and when peace came the men would come back to find the experiments a stage more developed than when they left. They could see the possibility of using to the great advantage of agriculture some of the machinery which was now being used for non-agricultural purposes. They hoped for some well-considered scheme for agricultural development in which the research stations, colleges, agricultural institutes and similar organizations would play a definite part.

Nature remarks: "The science of economic aviculture has probably reached a higher standard in the United States than in any other part of the world. This work is carried on by the Department of Agriculture, which, for years past, has spared no pains to enact laws and formulate schemes for the conservation of bird-life, whether for purely economic ends or for esthetic reasons. As a consequence, it has now available a mass of evidence as to the status and value of every species within its realms. The latest evidence of its enlightened policy takes the form of a bulletin—No. 465—on the propagation of wild-duck foods. The haunts and food values of no fewer than nineteen groups of plants, comprising sixty species, are here described, together with instructions as to stocking water in need of bait for these valuable birds. The characteristics of wild rice, wild celery, pondweeds, arrowheads, chufa, wild millet and water-lilies are all carefully set forth, and this information is accompanied by carefully collected data as to their attractiveness in regard to particular species of wild ducks. Had we followed its lead years ago our own Board of Agriculture would now be able to speak with authority when called on to sift the value of the crudely formed opinions of local agricultural chambers as to the usefulness or otherwise of our native birds in relation to our food supply. The latter is of vital importance, and the clamor for legislation is sometimes insistent. This war has done much for us already; perhaps it may yet bring into being a bureau of ornithology, such as is to be found now in many Continental states, as well as in America."

According to *Nature* the newly formed Russian Botanical Society held its annual, and also a special, meeting at Moscow on December 16–19, 1916, and its organization was then completed. The following officers were elected: *Honorary President,* A. S. Famincyn; *President,* I. P. Borodin; *Vice-presidents,* V. I. Palladin and S. G. Navašin; *Chief Secretary,* N. A. Buš; *Treasurer,* V. N. Suchačev; *Members of the Council* in Petrograd, V. L. Komarov, S. P. Kostyčev and V. A. Tranšel. In addition, the following were elected on the council as representing cities containing a minimum of five members of the society: M. I. Golenkin (Moscow), E. F. Votčal (Kiev), V. M. Arnoldi (Charkov), B. B. Grineveckij (Odessa), V. V. Saponžnikov (Tomsk), Ja. S. Medvědev (Tiflis) and V. M. Arcichovskij (Novočerkassk). The number of the acting members of the society now exceeds 280. Notwithstanding the present unfavorable conditions, more than eighty members attended the four days' meeting in Moscow, and, in addition to the discussion and settlement of various questions of organization, sixteen scientific reports were read. The next extraordinary meeting is fixed for December, 1919, again in Moscow. Thanks to a subsidy of 8,000 roubles received from the Ministry of Public Instruction, it was possible towards the end of the year 1916 to proceed with the publication of the *Journal* of the Russian Botanical Society, and the first issue was placed before, and approved by, the Moscow meeting. The second issue is in the press and finishes the year 1916. For this year a subsidy of 10,000 roubles is being applied for, and it is intended to publish eight numbers of four to five sheets each. Thus the scientific amalgamation of Russian botanists, for which they have long striven, may be considered as achieved, and the formation under the auspices of the Imperial Academy of Sciences of the first all-Russian learned society is an accomplished fact.

Nature states that under the title of "Science in Russia" a new reference-book will be published in the present year, composed of two parts: (*a*) an index of all scientific institutions, societies, and higher schools in Russia; (*b*) an index of all persons working in these institutions and of private scientific workers. It will thus include in the first part the particulars hitherto supplied (but very incompletely as to Russia) by the "Minerva Jahrbuch"; while the second part will be similar to "Who's who in science," but will give, at least for 1916, not so much information about each individual. The difficult task of collecting the necessary material is already well in hand. The undertaking has been brought, through the Russian newspapers, to the knowledge of all those interested, and special forms are being supplied to the institutions and societies, many of which have already been returned with the necessary particulars. The work has been taken in hand by the Academy of Sciences of Petrograd and the scientific periodical *Priroda* (Nature) of Moscow. "Science in Russia" for 1916 will be edited by Professor V. N. Beneševič, and published conjointly by the Academy and the Journal *Priroda* in the latter part of this year. It will be issued annually. This publication will supply a long-felt need, as up to the present the only work of reference containing any information about the scientific institutions of Russia as a whole has been "Minerva." "Science in Russia" will help towards an exact evaluation of Russian scientific forces and activity, and will constitute an important step towards the promotion of closer scientific relations with the Allied countries.

According to the *Journal* of the American Medical Association, plans have been taken up with the government for the establishment of an outpatient department at Camp Admiral by the officers of the Maryland Psychiatric Base Hospital Unit, of which Dr. A. P. Herring is chairman, and Dr. W. R. Dunton, secretary. The chief object of this department will be to examine soldiers for mental and nervous disorders and to arrange for their treatment, but specialists of various sorts of physical disease will also volunteer their services. The purpose is to have volunteers go to the cantonment at stated intervals and with army surgeons conduct thorough mental tests and physical examinations. The new psychopathic building at the Spring Grove State Hospital, designed for acute cases of mental disease, has been offered to the government, and if it is accepted, patients from Camp Admiral will be treated there. The psychopathic building will also be useful in treating soldiers returned from the front, 18 to 20 per cent. of whom, it has been found in England, are suffering from mental breakdown, temporary or permanent.

UNIVERSITY AND EDUCATIONAL NEWS

Austin C. Dunham, of Hartford, has offered as a gift to the Connecticut Agricultural College at Storrs, his Newington farm, which he has made into one of the best equipped farms in the state. Mr. Dunham has spent about $50,000 in improving the property and offers it to the college simply on the condition that it be used for school purposes. The farm consists of 130 acres and has at present forty head of cows and heifers and sixty-five pigs. Four silos have been built, housing 150 tons of silage, and eighty tons of hay have been gathered.

According to a decision handed down by the Supreme Court of Connecticut, Yale University must pay to the state inheritance taxes amounting to about $34,000. The university inherited about $750,000 from the estate of Justus B. Hotchkiss. The Probate Court decided that it was not liable to taxation on the ground that Yale, being exempted by law from paying taxes on property in this city, was thereby constituted a public institution receiving state aid.

Two members of the faculty of Cornell University who retired this year have been elected to emeritus professorships. They are George S. Moler, emeritus professor of physics, and R. C. Carpenter, emeritus professor of experimental engineering.

Dr. Victor C. Alderson, consulting engineer of Boston, has been tendered the presidency of the Colorado School of Mines at Golden, Colo. Dr. Alderson served as president of the school for four years, retiring three years ago. He has not yet indicated whether he will accept.

Promotions in the faculty of the New York State College of Agriculture have been made as follows: Assistant professors promoted to the grade of professors· J. R. Schramm, botany; R. H. Wheeler, extension teaching; H. O. Buckman, soil technology.

Professor V. Ascoli, of the chair of medical pathology of the University of Pavia, has been appointed professor of clinical medicine at Rome to succeed Bacelli.

DISCUSSION AND CORRESPONDENCE

CLIMATIC INDEX OF BONNEVILLE LAKE BEDS

Because of the fact that they have been thought to furnish undoubtable stratigraphic testimony in support of the conception of the duality of the Glacial Epoch the lacustral deposits of the Great Salt Lake basin of Utah hold at this time an especial interest. Where best exposed these beds occupy a vertical space of about 100 feet; but their total thickness is without question considerably greater than this figure. The main body of the formation comprises fine laminated calcareous materials, of uniform texture and yellow color. An upper section, of irregular thickness, from 2 to 20 feet, is notably limy, white and more or less indurated in certain layers. The white marly upper capping is sharply separated from the yellow lower beds by an irregular line of juncture which has every appearance of being a marked plane of unconformity.

The common historical interpretation of the general section is briefly this: The lower yellow beds are regarded as representing river silts deposited in the lake over a very long period of time when the early Bonneville water-level was nearly as high as the later Bonneville shore-line. The white marly beds are depositions of a shorter high-water stage of the lake. The irregular line between the white and yellow sections are viewed in the light of an unconformity, the interval represented being a stage between two high water marks when the old lake-waters completely dried up. Early Bonneville yellow beds are correlated in time with a first epoch of humidity superinduced by conditions of glaciation; while the white later Bonneville beds belong to the second Glacial epoch. The two parts of the section are thus represented as being separated by an erosional interval of long duration, occupying a time between two epochs of large rainfall and notable ice-forming.

Two features in particular militate strongly against these deposits either being normal stream-silts or being laid down during two distinct epochs separated by a long epoch of excessive dryness. This simpler and very different interpretation for the phenomena presented does not postulate violent and frequent changes of climate. It appeals to no other than the ordinary climatic conditions and geologic processes that prevail to-day in the region. It takes into account only the familiar geological activities of the desert.

Close examination of the deposits discloses the fact that they are not typical stream-silts, but that they have a grain very much coarser. In size the individual particles appear to be about midway between those of normal clay and fine sand. Although obscurely laminated the material in all physical aspects seems to be essentially loess or adobe. Thus, instead of being normal river-silts swept into still water these deposits really represent dusts, borne by the winds from the neighboring deserts, that have dropped on the surface of the lake waters and have settled to the bottom.

Compared with desert deposits of other regions the white marly upper beds of the section which have such a variable thickness are essentially what the Mexicans call *caliche*. It is formed through ordinary soil tension by which lime salts of porous formations below are carried to the surface of the ground, where the water evaporates, leaving behind the solids. In some places there is sufficient lime deposited interstitially to give the beds the aspect of chalk. Upon further induration some layers passed into limestone.

The juncture of the yellow and white beds is a sharp, irregular line that is easily mistaken for an erosion uncomformity. That it is not at all probable that in the Bonneville basin this line actually represents uncomformable relationships between the beds above and those below is clearly indicated by the fact that the phenomenon is a common one throughout arid lands where porous formations reach sky.

The yellow Bonneville clays do not appear, therefore, to represent a deposit which was laid down during a high-water precursor of the high-stage Lake Bonneville; and the irregular line separating the yellow and white sections does not stand for a long interlacustrine epoch when the lake waters were completely desiccated, during a dry interglacial time. The white marls seem to be very recent in formation, produced directly from the yellow clays long after Bonneville waters had finally receded. Their especial climatic significance is manifestly very different from that formerly postulated. The ascribed peculiarities are really every-day desert phenomena.

Charles Keyes

Des Moines, Ia.

INTERNAL TELIA OF RUSTS

To the Editor of Science: A recent article[1] lists up the references in pathological literature regarding the production of internal rust spores. The present writer in 1912[2] described such internal production of teliospores in the leaf of *Xanthium Canadense*, in the following words:

> Within the mixture of parenchyma cells and mycelium, which replaces the normal tissue, there are cystlike bodies which are composed of masses of mycelium. These objects are hollow spheres, and from the inner surface arise telial spores exactly similar to those borne in the normal way upon the exterior of the leaf.

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[1] "Discovery of Internal Telia Produced by a Species of *Cronartium*," by R. H. Colley, *Jour. Agr. Research*, VIII., No. 9, February 26, 1917, pp. 329–332.

[2] "Relations of Parasitic Fungi to their Host Plants," *Bot. Gazette*, LIII., No. 5, May, p. 381.

The writer is calling attention to this former note since it was included in an article upon a broader subject, which accounts for the oversight of the reviewer.

Ernest Shaw Reynolds

Agricultural College, N. D.

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

The fifth number of Volume 3 of the *Proceedings of the National Academy of Sciences* contains the following articles:

The laws of elastico-viscous flow: A. A. Michelson, department of physics, University of Chicago. A number of empirical formulas are given.

A new equation of continuity: Frederick G. Keyes, Research Laboratory of Physical Chemistry, Massachusetts Institute of Technology. A comparison of a modification of van der Waals' equation with experimental results extended over wide ranges, showing satisfactory agreement between the equation and experiment.

The classification of vascular plants: Edward W. Berry, Geological Laboratory, Johns Hopkins University.

Displacement interferometry in connection with U-tubes: C. Barus, department of physics, Brown University.

Attempt to separate the isotopic forms of lead by fractional crystallization: Theodore W. Richards and Norris F. Hall, Wolcott Gibbs Memorial Laboratory, Harvard University. One may infer that the molal solubilities of the nitrates are probably essentially identical, and that isotopes are really inseparable by any such process as crystallization.

Hybrids of Zea tunicata and Zea ramosa: G. N. Collins, Bureau of Plant Industry, U. S. Department of Agriculture.

Distribution of gall midges: E. P. Felt, New York State Museum, Albany, New York. A discussion of the existing distribution and of hypotheses concerning the way in which it may have been brought about.

Fertility and age in the domestic fowl: Raymond Pearl, Biological Laboratory, Maine Agricultural Experiment Station. There is a steady and progressive decline in fertility after the first breeding season.

A kinetic hypothesis to explain the function of electrons in the chemical combination of atoms: William A. Noyes, department of chemistry, University of Illinois.

Transverse displacement interferometry: Carl Barus, department of physics, Brown University.

The proteins of the peanut, Arachis hypogæa: Carl O. Johns and D. Breese Jones, Protein Investigation Laboratory, Bureau of Chemistry, Department of Agriculture, Washington. Peanut meal contains a high percentage of lysine and could well be used to supplement a diet of corn and wheat.

A design-sequence from New Mexico: A. V. Kidder, Phillips Academy, Andover, Mass. It has been possible to identify five successive steps in the modification of a design.

The equilibrium between carbon monoxide, carbon dioxide, sulphur dioxide and free sulphur: John B. Ferguson, Geophysical Laboratory, Carnegie Institution of Washington.

Physiological effect on growth and reproduction of rations balanced from restricted sources: E. B. Hart, E. V. McCollum, H. Steenbock and G. C. Humphrey, departments of agricultural chemistry and animal husbandry, University of Wisconsin. Studies pointing to the necessity of the accumulation of further information on the *physiological* behavior of feeding stuffs.

What determines the duration of life in metazoa? Jacques Loeb and J. H. Northrop, Laboratories of the Rockefeller Institute for Medical Research, New York. *Drosophila* has a temperature coefficient for the duration of life of the order of magnitude of that of the chemical reaction. Since we know that the duration of the larval stage is determined by a specific hormone, we must consider the possibility that the duration of life is also primarily determined by the formation of a hormone in the body.

The interrelation between diet and body condition and the energy production during mechanical work in the dog: R. J. Anderson and Graham Lusk, physiological laboratory, Cornell University Medical College, New York City. The accomplishment of a given amount of mechanical work is always at the expense of a given amount of energy and the amount of energy required for the mechanical work is independent of the physical condition of the subject and of the quantity of carbohydrate present in the gastrointestinal tract.

Report of the annual meeting: Award of medals, research grants from the trust funds.

Edwin Bidwell Wilson

Massachusetts Institute of Technology,
Cambridge, Mass.

SPECIAL ARTICLES

NOTE ON THE SWELLING OF GELATINE AND AGAR GELS IN SOLUTIONS OF SUCROSE AND DEXTROSE

The tests reported in this note were made incidentally in connection with experiments by D. T. MacDougal[1] on the swelling of cactus tissues (*Opuntia*) and of certain artificial gels in water and in dilute solutions of acids and alkalis. The method was the same in all particulars as that described by MacDougal. Small plates cut from thin, dried sheets of the various gelatine-agar mixtures were placed in the sugar solutions and the increases in thickness which occurred as these plates imbibed water and swelled were measured by the auxograph. The experiments were at room temperature, which ranged between 60° and 70° F. (16° and 21° C.). In all cases the gels were the identical preparations used by MacDougal. The sucrose was the usual "c. p." grade. The dextrose was Merck's "highest purity." The sugar solutions were tested for neutrality to phenolphthalein and litmus. Sugar concentrations are in percentages by weight.

The results are given in the following tables as percentage increases in thickness of the gel plates after approximately 12 hours in the respective solutions. The original thicknesses were measured by a micrometer gauge. Preliminary tests for longer time periods indicated that the swelling was always complete or very nearly so, in 12 hours. In the tables, figures on a single horizontal line represent tests made at the same time and under substantially identical conditions, the only differences being between the concentrations of the sugar solutions.

EXPERIMENTS WITH SUCROSE

Gelatine (without Agar)

Distilled Water	0.5% Sucrose	2% Sucrose	5% Sucrose	25% Sucrose	50% Sucrose
250	315				
250	250	210	260	210	

Gelatine 100—Agar 1

630	670				
620		710	550	520	330

Gelatine 80—Agar 20

300	350				
550		400	450	500	250

Gelatine 50—Agar 50

875	850				
600		525	500	450	275

Gelatine 20—Agar 80

1,150	1,050				
1,100		1,375	1,150	1,175	425

Agar (without Gelatine)

825	733				
1,000		1,175	900	700	350

EXPERIMENTS WITH DEXTROSE

Gelatine (without Agar)

Distilled Water	2% Dextrose	5% Dextrose	25% Dextrose	50% Dextrose
260	310	240	210	210

Gelatine 80—Agar 20

300	450	400	500	375

Gelatine 50—Agar 50

625	525	400	375	350

Agar (without Gelatine)

1,200	1,175	900	725	500

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[1] Science, N. S., Vol. XLIV., pp. 502–505, 1916.

For the sugar solutions having concentrations less than 25 per cent. the results do not differ from the results for distilled water more than is explainable by the accidental variation normal to the method when the temperature is not controlled precisely. The effects of one hundredth normal acid and alkali found by MacDougal were many times the variations here observed and one may conclude that neither sucrose nor dextrose, in concentrations under 25 per cent., has any important effect on the swelling of gelatine-agar gels in water; important, that is, in comparison with the effects of acids or alkalis. With sugar concentrations of 50 per cent. the data show a markedly lessened swelling of all the gels in sucrose and of the two low-gelatine gels in dextrose. It may be that the two high-gelatine gels also swell less in 50 per cent. dextrose but the decrease is not certainly determinable from the single test which was made This decrease in swelling in concentrated sugar solutions is to be expected from analogy with the osmotic behavior of such solutions and does not indicate any specific effect of either sugar on the swelling or imbibition capacity of the gels themselves.

E. E. FREE

DESERT BOTANICAL LABORATORY

THE AMERICAN CHEMICAL SOCIETY
III

DIVISION OF INDUSTRIAL CHEMISTS AND CHEMICAL ENGINEERS

H. E. Howe, *Chairman*
S. H. Salisbury, Jr., *Secretary*

A new method of separating zinc from cadmium and the latter's determination iodometrically: ERIC JOHN ERICSON. The separation consists in crystallizing the zinc out as zinc sulphate or zinc ammonium sulphate. It may be applied to the determination of cadmium in ore or in spelter (after removing and determining lead). In the latter case, although a small trace of cadmium is entrained in the crystals, only one crystallization is deemed necessary in view of the large sample taken. After removal of zinc, the cadmium may be determined by any of the usual methods. An iodometric method is outlined.

The determination of cadmium in brass: E. SCHRAMM. Owing to the lack of any well-tried method for the determination of cadmium in brass, a series of analyses was carried out on brasses and on mixtures of salts with and without additions of cadmium. A procedure was developed which gives fairly reliable results for the small amounts of cadmium concerned. The method consists essentially in removal of the copper electrolytically from nitric acid solution, followed by separation of the cadmium from zinc with hydrogen sulphide, in solutions of regulated acidity and small volume. The cadmium is finally weighed as sulphate.

The electrometric titration of zinc: F. RUSSELL V. BICHOWSKY. In the potassium ferrocyanide method for determining zinc there are three principal sources of error: (1) Oxidation of the ferrocyanide by any nitric acid, chlorine, or bromine present; (2) precipitation of other metals along with zinc; (3) uncertainty of the end point. To remove the first source of error precautions such as the addition of SO_2 should be taken. To avoid the precipitation of other metals the rational procedure is to change the conditions of the ferrocyanide precipitation by carrying it out in solutions containing from 10 to 20 per cent. HCl. In these solutions zinc ferrocyanide is only slightly soluble, but lead, manganese, iron and copper ferrocyanides are very soluble. Since the ordinary indicators can not be used at this concentration of acid, an electrometric determination of the end point is adopted, which is found to be quicker and more accurate than the older methods. This consists in noting the point at which there is a sharp change in potential of the solutions against a platinum electrode. The apparatus is the same as that used in determining the end-point of oxidation and reduction reactions in the analysis of iron, vanadium, chromium, etc. Experiments on a number of salt mixtures show that the end point is not affected by the amount of acid or neutral salts present within reasonable limits, nor by the presence of iron, lead, manganese (up to 50 mg.), or by small amounts of copper and cadmium. The preliminary operations for the purification of the ore therefore lose their customary importance; comparative results show that the electrometric method is more rapid than the usual procedure.

The vapor pressure of zinc and related metals: JOHN JOHNSTON. A review of the somewhat scattered observations on the vapor pressure of high-boiling metals, and a reduction of the data yielding equations by means of which the vapor pressure at any temperature can be ascertained. Published observations on the volatility of metals, alone and from mixtures, are also summarized.

The new zinc fields of Kansas and Oklahoma: W. P. Haynes. A visit to the new zinc fields south of Baxter Springs, Kansas, and to Picher and Admiralty, Oklahoma, shows the great strides in production which this district is making. Small drilling rigs dotting the prairie mark the advance guard, prospecting to determine the value and extent of the ore bodies. Concentrating mills follow closely and give the appearance of a large city. The ore minerals in this new district are chiefly sphalerite with some galena and variable amounts of pyrite and marcasite. This ore is much richer than in the older Galena-Joplin district and frequently contains over 20 per cent. of sphalerite. The origin of the ores of this district is still somewhat in doubt, but the most recent researches by Siebenthal have led him to conclude that they have been produced from the disseminated sulphide minerals scattered through the Cambro-Ordovician limestones, by artesian waters transporting them in solution and ascending and depositing them in the open spaces of the cherty members (Grand Falls chert) of the Boone formation (Burlington or Mississipian limestone), which is the productive horizon in this region.

Recent investigations on the smelter smoke problem: A. E. Wells. At most smelters where large quantities of sulphide ores are being handled, serious efforts are being made to utilize through the manufacture of sulphuric acid, liquid dioxide or elemental sulphur, the sulphur dioxide which results from the roasting and smelting of these ores. However, at plants situated at a considerable distance from markets for these products, only a comparatively small amount of the sulphur can be so utilized. It is recognized that although the amount of the smelter waste sulphur gases that will be utilized in commercial products will be increased steadily, yet, for many years to come, these smelters will be obliged to waste large volumes of sulphur dioxide daily into the atmosphere. Therefore, efforts are being made to determine how, under different climatic and topographic conditions, these large volumes of sulphur dioxide can be discharged into the atmosphere without doing injury to vegetation in the surrounding country. In this paper the development of the methods for conducting these investigations were discussed briefly.

Notes upon the hydro-metallurgical and electrolytic treatment of zinc ore: E. E. Watts. After briefly discussing the treatment of zinc ore, the paper related the writer's experimental work upon the ore of the Sullivan Mine of Kimberly, B. C. This work served to develop a process that involved a sulphurous acid leaching of the ore, and further experimental work developed the Watts Process. By this process, zinc oxide obtained by any suitable means is treated in specially constructed electrolytic tanks for the recovery of zinc. The work done in the experimental plant of the Electro Zinc Company at Welland, Ont., was discussed.

Chemical examination of industrial brines: O. R. Sweeney and James R. Withrow. The value of chemical examination, from the manufacturer's standpoint, was discussed. The errors resulting from improper sampling were shown, and a suggestion for a standard method given. The constituents which it was thought should be determined were given; together with the form in which they should be reported. A standard procedure for determining the density was given and the best temperature to use was discussed. Suggestions for determining total solids from the author's experiences were given. Procedures for silica, iron and aluminum were given and shorter methods for calcium and magnesium in mineral waters. Barium, strontium, sodium, potassium and sulfuric acid procedures were given, also modifications of the methods for bromine determination.

Contribution to the industrial chemistry of chicle and chewing gum: Frederic Dannerth. The author presents methods for the valuation of commercial block chicle by determining moisture, viscosity, resins, proteins and carbohydrates and mineral matter. Twenty problems relating to the chewing gum industry are presented. The total exports of finished chewing gum, amounted in 1916 to $574,400, equivalent to approximately 718,000 pounds. This represents crude chicle equal to at least 179,000 pounds. The amount of chicle imported, manufactured and consumed in the United States in 1916 was approximately 7,031,000 pounds equivalent to 28,124,000 pounds of chewing gum. Researches are at present being carried out on the constituent elements of chicle—alpha chicl-alban; beta chicl-alban; gamma chicl-alban; chicl-fluavil, and chicl-gutta. These substances have been investigated by Tschirsch and later by Bosz and Cohen. The latter investigators have not entirely agreed with the results published by Tschirsch.

Apparatus for determining the specific gravity of natural gas: Chas. K. Francis. The apparatus is to be used according to the method proposed by

Bunsen, which is based on the fact that the specific gravity of two gases bear approximately the same ratios to each other as do the squares of their rate of flow when passing through a very small opening. The apparatus consists of a pipette or burette to which is sealed at right angles, just below the tip, a glass stopcock. To the tip of the burette another stopcock is sealed which is provided with a very small, practically invisible opening. The gas to be examined is admitted through the larger side opening and the time of escape is measured through the small opening. A sample of air is measured in the same manner. The following example will serve as an illustration: The time required for the sample of gas to escape was 13.4 seconds and for the same quantity of air, 11.8 seconds; these squared are equal to 190.4 and 129.9. As the specific gravity of natural gas is referred to air as unity, the specific gravity is obtained by dividing 129.9 by 179.5 = 0.723 the specific gravity of the gas.

Comparative results from experiments in the distillery with open and closed fermenters: Niels C. Ortved. A closed iron fermenter of the latest type with a capacity of 4,000 liters was brought from Germany in 1914 and a wooden open tub of the same capacity was constructed. Eleven experiments were made, fermenting simultaneously mash from the same batch in both vessels. The results obtained were in favor of the closed fermenter, viz., lower acidity in the finished beer, and increased yield, amounting to one per cent. of spirit. The yields from the open fermenter corresponded to the average yields obtained in the ordinary normal runs of the distillery.

The effects of exposure of some fluid bitumens: Charles S. Reeve and Richard H. Lewis. The work described was a continuation of that begun by Hubbard and Reeve (*Jour. of Indus. and Eng. Chem.*, 1913), and of later results published by Reeve and Anderton in the *Journal of the Franklin Institute*, October, 1916. Experiments were carried out along similar lines to those previously followed, using fluid types of products which had not been previously investigated. Exposure tests conducted for a period of one year show that certain types of petroleum harden materially while others are relatively little changed in their physical character, although all are materially changed in their composition as shown by the change in percentage of bitumen insoluble in naphtha and free and fixed carbon values. The relation between amounts volatilized upon heating for various periods in a laboratory oven at 163° C. and the amounts lost upon atmospheric exposure were shown by tables, and relations between the characters of the residues obtained by the two methods of volatilization were given. As in the previous work referred to, the changes which occur in bitumens upon exposure are notably greater than can be accounted for by mere loss of volatile constituents, and are due to chemical changes in the constitution of the bitumen itself.

The thermal and pressure decomposition of an absorbent oil: Gustav Egloff. An absorbent oil derived from a Pennsylvania crude petroleum, specific gravity 0.828/15.5° C. and 95.3 per cent. boiling between 250° C. and 350° C. was subjected to temperature conditions of 550° C., 600° C. and 650° C. in the gas phase at one and eleven atmospheres pressure. The above conditions of temperature and pressure gave the following percentages of gasoline, benzene, toluene and xylenes on basis of oil used.

Basis of Oil Used	Temperature Pressure in Atmospheres					
	550° C		600° C.		650° C	
	I	II	I	II	I	II
Per cent. gasoline...	11.6	19.5	16.4	18.8	16.8	14.2
" benzene...	0.0	0.0	0.8	3.4	2.5	5.5
" toluene...	0.6	1.7	1.5	4.4	2.9	4.4
" xylenes...	0.3	1.7	0.6	2.8	1.6	2.2

The formation of benzene and toluene by the action of aluminum chloride on solvent naphtha: Gustav Egloff. Solvent naphtha derived from the thermal decomposition of coal, having a specific gravity of 0.867/15.5° C. and 93 per cent. distilling between 135° and 160° C. with the dry point at 181° C. was treated with anhydrous aluminum chloride. Five per cent. by weight of $AlCl_3$, was added to one liter of solvent naphtha and distilled over in two hours from a Hempel flask until 78 per cent. came over. The distillate was neutralized with caustic, washed and dried over calcium chloride. The distillate upon analysis gave on the basis of solvent naphtha used 1.2 per cent. of benzene and 13.9 per cent. of toluene.

The determination of available oxygen in oxidized manganese ores: O. L. Barneby. The oxalic acid method is in common use in America for the determination of available oxygen in oxidized manganese ores and hence is the basis for the evaluation of such ores for certain industrial purposes. This method gives inconsistent results causing much difficulty in control work involving the use of pyrolusite and similar products. The method is shown to be highly empirical, the errors being produced by decomposition of the oxalic acid by the action of the light in the presence of manganese salts. A modified ferrous sulfate method is accurate and is recommended for factory control work. The latter method gives results in close agreement with results obtained by Bunsen's distillation method and a new direct iodimetric method worked out by the author.

Some relations of the effect of over-heating to certain physical and chemical properties of asphalts: A. W. Hixson and Harold E. Hands. An oil asphaltic cement, a brick filler fluxed with an asphaltic oil residuum and a crude Trinidad asphalt were heated to various temperatures between 163° C. and 350° C. under uniform conditions. Physical and chemical analyses were made on the products of the various heatings. The results show that heating asphalts above certain temperatures change both the physical and chemical properties. The carbene content was not changed materially until the temperature of heating was above 200° C. Above that temperature there was a decided increase in carbenes. The results seem to indicate that carbenes are the result of cracking paraffine and asphaltic hydrocarbons into napthenes and unsaturated hydrocarbons. Moderate heating may so change the nature of the asphalts as to render them more soluble in carbon tetrachloride than in carbon disulphide. Overheating causes marked changes in natural and oil asphalts which render them unfit for many structural purposes. Two hundred and thirty-five degrees Centigrade is probably the maximum temperature to which an asphalt may be heated without permanent injuries to its useful properties and for certain structural purposes they should not be heated above 200° C. It is believed that the fixed carbon content when corrected to the original weight before heating offers a means of tracing the changes in the molecular structure of the hydrocarbons when they are subjected to the influence of heat. There is a close relation between the carbene value and the physical and chemical properties of asphaltic materials. The carbene specification is important for asphaltic materials for construction purposes.

Chemical Industry in Canada: H. E. Howe. The paper outlined something of the chemical industry in Canada, with special reference to recent important developments and new processes which have been perfected under the stimulating influence of war conditions, but which will become important factors in the chemical business after the war. It also recounted something of the natural resources of Canada as indicating the raw materials upon which chemical processes and industries may eventually be based, concluding with the statement of the steps that are being taken by private corporations, educational institutions and the government to apply scientific and industrial research looking toward the more economic utilization of natural resources and the establishment of chemical industries to serve a population which will undoubtedly increase at an abnormal rate following the declaration of peace.

The availability of nitrogen in fertilizers. A new method based on the nitrogen rendered water-soluble by incubation with a fertile soil: J. P. Schroeder. Theoretical and practical considerations governing the availability of substances for plant nutrition in recent researches dealing with the assimilation of various forms of nitrogen and the merits of various methods for determining availability were discussed. A proposed method consists of incubating a small sample of fertilizer with a 100 gm. portion of fertile soil at 30° C., maintained just below its critical moisture content and determining the total nitrogen that has been converted into the water-soluble form. It differs from the nitrification method and the ammonification method in that it takes into consideration both of those forms of nitrogen; also that in the form of nitrites and soluble protein compounds, all of which are assumed to be available or readily convertible into available form. It makes possible a shorter incubation period than in the nitrification method and the use of the exact ammonia determination instead of the difficult nitrate estimation.

The fertilizer value of city wastes—II., garbage tankage: J. P. Schroeder. The origin and composition and principal methods of rendering garbage were briefly outlined. Complete analyses of twenty samples of garbage tankage, representing all the larger garbage reduction plants in operation in this country, show on the average 3.3 per cent. ammonia, 7.84 per cent. bone phosphate and 0.80 per cent. potash, after removal of the oil, which usually amounts to about 12 per cent. Calculations based on these analyses and on figures showing production in cities of 50,000 and over, call attention to the large source of ammonia available. The availability of this ammonia for plant use is shown by experiments with different methods, and the general applicability of the material for fertilizer purposes based on its physical and chemical properties was discussed.

SCIENCE

FRIDAY, AUGUST 17, 1917

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THE FUTURE OF THE SIGMA XI[1]

IN a few weeks it will be thirty-one years since some students of Cornell University, feeling the injustice of the old-fashioned kind of education that gave all its honors, all its encouragement to the students of the liberal arts, planned an honor society in the sciences. They thought, as most of us now think, that not all of good was confined to Latin and Greek, that there was also merit in the natural sciences, that the student of geology or of engineering was as deserving of honors and of encouragement as the student of the classics. As they walked home from the commencement where the honors of Phi Beta Kappa had been liberally bestowed, they conceived a society that would recognize in an equal way the merits of the bachelor of science. And the Sigma Xi was born.

But higher education in America, as in all nations, has developed much since those days, and that exponent of the liberal education of those days has also changed. The Sigma Xi of 1886 would find little encouragement in most of our universities to-day, and we of the Sigma Xi may justly claim some of the credit for that change. The classical education of fifty years ago has but few proponents to-day, for science is now recognized as an essential part of any liberal education.

Perhaps some of us are claiming too much for science in education; I half believe that we are. When I received my bachelor degree, a good many years ago, my commencement speech was a diatribe on Latin and

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[1] An address delivered to the initiates of the Yale chapter of the Sigma Xi, April 2, 1917.

Greek, which had exacted a full half of all my college work. But, I have frankly to admit that my debt to them is great, great because the science of those days was not a substitute for them, nor am I fully convinced that it yet is.

The Sigma Xi was founded, we may frankly admit, merely as a rival for the Phi Beta Kappa—perhaps there was a flavor of sour grapes in its origin! Has it justified its past? Is there justification for it to-day, and need for it in the future? Without reservation the answer to all these is yes. But, for the Sigma Xi of 1886 the need was brief. Science has won recognition as an essential part, though not the whole part of any liberal education. There was a time, not so very long ago, when studies of immediate bread-and-butter interest were debarred from the curriculum for the bachelor of arts degree as contaminators of a liberal education. I can remember a long and warm discussion in one of our large universities as to whether the study of human anatomy might safely be substituted for that of cat anatomy; not because the study of man was less worthy than the study of cats, but because the one was pursued for a practical purpose while the other was merely disciplinary. My colleagues of the language side feared that it would be, as indeed it was, a wedge to make education practical as well as cultural. Similar discussions are not often heard now in our faculty meetings. To preserve the degree of bachelor of arts in all its pristine aristocratic purity, the degrees of bachelor of science and of philosophy, and of I know not what else, were widely introduced for the proletariat in science. For a long time they were the penumbra of classical learning, and even yet in some places they have not won their full place in the sun. I hope that the time will soon be here when there shall be no distinctions anywhere between the student of Greek and the student of botany or chemistry, or of psychology. One is as useful in its way as the others, and has an equal place in liberal education, but not to the exclusion of others. This is now so evident that the statement would be a mere platitude, were it not that the Sigma Xi was founded expressly to help break down the distinction.

The Sigma Xi has long since ceased to look exclusively upon the other side of the Phi Beta Kappa shield. The ideals of our society are not those of its founders thirty years ago, when the simple recognition and encouragement of scientific studies were the most that it could do. Its higher ideal is now, as it has been for years, I can say with your unanimous approbation, the encouragement of productive scientific scholarship. The encouragement of scientific scholarship is but a part of its function. The student who, when he dons for the first time his academic gown, is able to talk learnedly of what his text-books and teachers have taught him about chromosomes, the mutations of *Œnothera,* dominant and recessive characters, the location of Cambrian rocks, the secret history of trilobites and dinosaurs, or the mysteries of ions and organic compounds, is a worthy candidate for membership with us, but he has not justified his right to full fellowship with the Spoudon Xunones until he has given evidence of his ability and desire to use that knowledge for the benefit of science. Our ultimate ideal, then, in a few words, is the encouragement of research. And the student may properly ask, what do you mean by research?

The word is something of a fetish with us. Is counting the number of feathers in a bird's wing, or the hairs in a mosquito's antenna research. Yes, if it leads the student better to understand the structure of all birds and all flies. Otherwise it might as well be done by a properly constructed machine. We have been told that the mere accumulation of simple scientific facts never makes a leader in science, that, for instance, the collection of birds and bugs and brachiopods and their discrimination into species and subspecies is an inferior kind of research in natural history. But, every scientific man of repute in the past or present has begun in just that way, by the discovery and discrimination of scientific facts, however simple they may appear to others. Lamarck was a mere collector and namer of mollusks; Charles Darwin wasted years of his brilliant life in classifying cirriped crustaceans—I wonder how much those cirripeds had to do with natural selection, and I wonder how many of us would know a cirriped if we should meet one? Agassiz gave years of his life to the collection and study of poissons fossiles, and it requires no more acumen to classify fossil fishes than living bugs, for I have tried both. The collection and discrimination of mosquitoes was once a puerile pursuit. But, had there been no collectors and classifiers of mosquitoes, yellow fever would still be ravaging our seaports, and perhaps the Panama Canal would not now be a reality, and the safety of our nation endangered. Can any one see any possible relation between a mere entomological collector and the destruction of great cities by war? Had not Loewenhoek, in mere curiosity, found those organisms we call bacteria, and others wasted their time in studying and classifying them, there would have been no Pasteur, and antitoxins unknown. Is there no relation between such trivial pursuits, as some of our friends would call them, and typhoid fever?

I say, and say with deep conviction, that the ability displayed in the observation and discrimination of what often appear to us to be trivial things may be as great as that required for the formulation of far-reaching laws in science. Even the tyro can draw conclusions, that is, recognize laws, when facts are numerous enough, and the best of us can do nothing without facts. And the discovery of natural laws is sure to come when facts are numerous enough. It is the trained student who anticipates them. How many great discoveries or great inventions have uncontested claimants? Who was the discoverer of electricity, photography, telegraphy, telephony, aviation, or even evolution?

Let us not, then, deride the student because he is doing what we in our conceit think is unimportant. There are fashions in science as in everything else, and we are rather inclined to ridicule him who is not quite up to fashion. Shall we tell the candidate for honors in Sigma Xi that he must be in fashion? That research is research only when it leads to worldly recognition? No, train him aright, and nothing will be too trivial to merit his study. It is not *what* he does but *how* he does it that makes the leader in science as in everything else, for there is nothing small in science.

One of our noted chemists, not long ago, I have been told, after the publication of an important paper, when asked by the president of his college of what use his discoveries were to the world, replied that he hoped they had none. We would not wholly agree with him, because the ultimate end of all our research is the benefit of mankind, and there surely must be some practical use of every fact in science. He did emphasize, however, the first essential of every true scientist, the desire to learn new truths for the sake of truth.

Research ability I would define as the ability to observe, to discriminate, and to judge, coupled with an intelligence that is always asking the reason why. Given this ability to observe and to understand, and its possessor has the foundation for success, whether in science, in arts or in the everyday affairs of life. Every day life is but a continual round of original research for every successful physician, lawyer, statesman or business man. And this is the highest aim of our society, to encourage the training of such students. As teachers our pupils look to us for inspiration and he only can give inspiration who knows the joy of research himself.

As a society for the mere giving of honors for scientific scholarship we have outgrown our past, and indeed that was our function only for a brief time. But we still have a duty to encourage scholarship, for without scholarship there can be no research. It is human nature to seek honors. Scientific men, like all others, from the humblest to the greatest, welcome them, whether it be membership in the Sigma Xi or in the National Academy of Sciences. When honors come as rewards for meritorious work accomplished they cheer and encourage; and they stimulate ourselves and others to higher efforts. We would not, if we could, abolish honors for scholarship from our society, we would not restrict them to accomplished research.

And our colleges and our nation need us for the higher work; never was there greater need for the work we can do, and these dangerous days are impressing us with that need. Until the millenium comes when we shall all live in peace and harmony, and like the dinosaurs grow big, fat and vulnerable and like them become extinct, the nation will need the utmost we can do in science.

Is it merely a coincidence that the life of the Sigma Xi has been nearly synchronous with the marvelous development of science in America? When this society was born there were but a few score of noted research men in science, and but one or two special societies in science. Now we number our alumni by the thousands, active research men by the hundreds, and scientific societies by the score. Then it was necessary for young men who would do things in science to go abroad, and chiefly to Germany, for their training. Who is there now who finds it necessary to go abroad for lack of suitable instruction here? It was not many years ago that I heard the justly famous Dr. Koch, of Germany, say that America was becoming the leader in medical education and that soon it would be necessary for foreign students to come here for their best training. We have been told so many times by our scientific friends abroad that we are precocious but still undeveloped in science that we have been inclined to believe them. But that time has passed. I say, not in boastfulness, but in conscious truth, that to-day America is doing more research work in nearly every branch of pure science than any other nation upon the globe. And the quality of our work suffers not in comparison. I have grown a little weary of the common assumption that we are still looking across the water for our inspiration and guidance in scientific research.

We are doing more work, we are doing quite as good work in pure science, not because we are any abler or better than other people, and especially Germany, but because ours is a democratic nation that gives to every one opportunity and stimulus; because we are less bound by precedent, because the teachers of our colleges and universities are less creatures of control. In Frankfurt-on-the-Main I was told, a few years ago, that the national government would not permit the privately endowed university they were founding there to appoint its own faculty. It reserved the privilege of making every professor a creature of the controlling government. Fancy what our progress would have been in America had a self-perpetuating cabinet of the national government had the power to nominate every teacher in every college of our land!

These are some of the reasons, I am sure, for our remarkable development in pure science during the past forty years, some of the reasons why we may look forward to still greater progress in the coming years. Has our society had no part in this progress? Shall its part in the future be greater, or less? Do our colleges and universities still have need of us to strengthen, to sustain?

In one great side of science, however, for which our society stands, we, as a nation, have failed as compared with others, and especially Germany. Applied science, I mean, or at least some branches of it. England is awakening to its negligence in the past; never in the history of the empire has the scientific man of Britain been more appreciated than he is at present. And there is a new epoch for America coming soon. We have our Langleys, our Maxims, our Bells, Edisons and Wrights of whom we are proud, but our colleges have not had much share in their production, and we in the pure sciences are still a little inclined to look askance at them as the antithesis of that supposed ideal of our famous chemist. Has the Sigma Xi done all that it should in the past to encourage the applied sciences? Shall we give greater encouragement to the student who counts the bristles in a mosquito's proboscis or the plasmodia in its stomach than to him who applies that knowledge to the prevention of yellow fever? Does it require less ability, less research to observe, to discriminate, to judge in the construction of an airplane or a talking machine than to trace the fibers of a cerebral ganglion, or reconstruct the backbone of a dinosaur? Have we done what we should? Or shall we frankly restrict ourselves to the encouragement of research in pure science and leave its application for others to further, to encourage? I believe that the decision is now before us, and upon our answer depends much of the future of our society. Trained as a young man in two professions of applied science, and the most of my life given to research in science so pure that its application to things practical seems remote in the extreme, perhaps my sympathies with both are more pronounced than usual. I can see no difference in the quality of research that I gave to locating a railroad line, the treatment of a patient with measles, or the reconstruction of a paleozoic reptile. It would be a misfortune for us, I earnestly believe, to restrict ourselves to the encouragement of research in pure science.

A great future, I am sure, for science in America is its application, and the greater efficiency we reach in making use of the many discoveries of pure science for the amelioration and improvement of our conditions as a nation, the higher will be the honors, the greater encouragement we shall receive in the discovery of new facts and of new laws; the more honorable, the more appreciated will be the profession of the research student in pure science.

Because we as a society have not done all that I think we should have done in the encouragement of the applied sciences, numerous rival societies in our technological schools have come into existence. We are all working for the same objects, why should our efforts be weakened by rivalries? Why should we not all be united in a single great organization for the promotion of all branches and sides of science? I feel sure that the greater extension and the greater usefulness of the Sigma Xi has been hampered by our lack of accord in our ideals. Some of our chapters grant membership almost wholly for high scholarship, others exclusively to graduate students who have accomplished or are accomplishing meritorious research work. And this lack of unanimity has prevented, I am sure, the greater extension of the society. We have but thirty chapters, an increase of but ten in the past ten years or more. There are at least a hundred institutions in America that need such encouragement as we can give. We have hesitated to extend our society, not because we are aristocratic, but because we earnestly desire to keep its ideals high, and know no way by which to ensure their preservation.

A step has been taken, one that I have hoped for for years, to define more precisely our ideals that we may entrust them fearlessly and safely to every institution where a few of us are gathered together. And I am still further encouraged to believe that in the end, even though it be slowly, it will lead to the results I have long hoped for, the extension of our society throughout our nation. Other organizations are doing much for the promotion of scientific research; ours is the nobler duty to train men and women for research in science, both pure and applied, to sustain, to encourage the university in the development of the science of the nation. Yale has done very much in the past, I am sure it will take its full part in the advancement of the future. Its ideals have always been high and they have been reflected in the chapter of the Sigma Xi. I can say with assurance that in no chapter of the society is the honor of election to membership greater.

In conclusion, I would say a few words to the initiates of this evening. You have pledged yourselves to uphold and sustain the ideals of the Sigma Xi. An honorable, a useful future lies before you. The world needs you as it has never needed such men as you before. Your vocation in life is more honorable than it ever has been before in the estimation of the world. I am sure that when you shall have reached my age, science will have won far greater honors yet for its earnest and sincere devotees, even as it has changed marvelously since the time when I was as young as you are.

New facts and new laws awaiting your discovery are as numerous as ever. Your work may be greater, but you are equipped to do that work more easily than we were a score or two years ago; your footsteps will be more direct, and the harvest that awaits your reaping is very, very great. And I would encourage you with the assurance that, no matter how humble that work may seem to you, if you have learned rightly to observe, to discriminate, and above all, to judge, there are no limits but your energy and your ambition to the heights you may climb.

SAMUEL W. WILLISTON

UNIVERSITY OF CHICAGO

THE WORK OF DEAN H. L. RUSSELL

DURING commencement week his colleagues, friends and former students celebrated the twenty-fifth anniversary of the doctorate of H. L. Russell, dean of the College of Agriculture of the University of Wisconsin. In 1892 Johns Hopkins University honored Professor Russell by conferring this degree upon him. This year (1917) also marks the completion of twenty-four years of service to the University of Wisconsin. The last ten years of this period have been occupied in directing the activities of the College of Agriculture and the Experiment Station.

At the anniversary last week bound records of the results of the work accomplished by Dean Russell were presented to him. Three sturdy volumes there were—nearly two thousand pages.

"What Dean Russell has meant to Wisconsin and her farmers purely as an investment cannot be estimated, so extensive have been his activities and so far-reaching their results," said E. G. Hastings, professor of bacteriology, in speaking of the relation of Dean Russell's work to Wisconsin and her farming industry. Professor Hastings has been closely associated with Dr. Russell in his work as a bacteriologist, having worked with him when he was head of the department of bacteriology and becoming head himself when the position was vacated by Dr. Russell. Professor Hastings said:

> At the time Dean Russell was graduated from the University of Wisconsin in 1888, bacteriology was just being developed at the university. The history of what bacteriology has done for the control of many animal diseases, such as hog cholera, anthrax, black leg and bovine tuberculosis—diseases which formerly killed off thousands of head of live stock annually; of what it has done for the production of milk and the consequent lowering of the nation's death rate, especially among infants; of what it has done for the control of plant diseases, thereby saving millions of dollars to the country annually by increased crop production; of how the cheese industry has grown with increasing knowledge of bacteria, of what has been learned about the power of nitrogen-fixing bacteria, to enrich the soil and thus increase the crop yields, of how it has brought about improved sanitary conditions, and how it has helped with the canning industry and the preservation of food by other methods—the history of all this, which is the history of agricultural bacteriology during the past twenty-five years, speaks for the wisdom of spending money and time on the study of bacteriology in any state, and especially in a state with the dairy and crop record of Wisconsin.
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> The introduction of bacteriology at the University of Wisconsin was due to the efforts of Dr. Wm. Trelease, now of the University of Illinois, and to Dr. E. A. Birge, dean of the College of Letters and Science of the University of Wisconsin. The first announcement of courses in this subject was contained in the university catalogue issued in 1887–1888. It may seem strange that even before the science of "bacteriology" had received its name, it had found a place at this then far-western institution. This was due to the fact that those persons in charge of the university were men with the spirit of the pioneer. A pioneer must be a progressive man, a man who is always on the job, a man of good judgment as to the road to follow. Such men Wisconsin had.
>
> Dean Russell became interested in bacteriology early in his career as a student, and under the influence of his teacher, Dr. Birge, he decided to go to Europe for instruction under the masters of what was then a comparatively new subject. He studied at Berlin while Robert Koch, the great pioneer of medical bacteriology, was actively engaged in teaching and investigating, and at Paris while Louis Pasteur was still busy in his laboratory. He returned to America and spent one year under Dr. William Welch of the Johns Hopkins University, thus completing the eighth year of his preparation for work—a long time in getting ready to work but the wisdom of this is shown in the things accomplished in the next twenty-five years.
>
> About this time, in northern Germany and Denmark, the relation of bacteria to dairying, especially to the manufacture of butter and cheese, was beginning to attract attention. W. A. Henry, then dean of the College of Agriculture, with true pioneer spirit, realized that Wisconsin was destined to be a great dairy state if matters were rightly directed; it had great natural resources in lands, in climate and in men—for it had within its borders such men as Governor W. D. Hoard and Hiram Smith. Dean Henry's task was to make his institution do its share in the development of this industry. Looking back upon his work from the present day, no one can question his success.
>
> Dean Henry decided that dairy bacteriology was something he must introduce in the work of the experiment and the college. It was most natural that his attention should be directed to the first student of the university to adopt it as a life work. Dean Russell came to the College of Agriculture in 1893, and immediately began work on the relation of bacteria to dairying and to bovine tuberculosis. The tuberculin test was just being introduced into this country, the Experiment Station herd being the first one west of the Alleghenies to be thus examined. This test revealed a sorry state of affairs; twenty-five out of thirty animals were found diseased. The herd was slaughtered. The new herd, which was assembled has been kept practically free from tuberculosis for twenty years. Animals have been introduced that later have reacted to the test, but the consistent and persistent use of the test has prevented any spread in the herd. True, expense has been involved in this work, but returns have been brought, both in money to the state and satisfaction to those in charge of the herd. Back in 1894, if the breeders of Wisconsin had adopted the advice given in Bulletin 40 of this station published that year, the state would have been in a far more enviable position as far as tuberculosis goes than at present.
>
> Another subject which received much attention and which has accomplished an endless amount of good, was the study of the contamination of milk—the sources of such contamination and its prevention. The work done in pasteurization of milk outlined the method which is used so widely at the

present time for the treatment of market milk, a method that was not actually put into practice until ten or more years later because the industry was not ready for it. It is certain that the credit that should be given Dean Russell for his work on pasteurization of milk has not been bestowed because it came at too early a period in the development of the industry.

Various other fields of farming investigation have engaged Dean Russell's attention, including the study of bacterial diseases of plants, especially the black rot of cabbage. One of the lines of effort in which study of bacteriology has yielded results of great practical value was the relation of bacteria to the ripening of cheddar cheese. The discovery that cheese could be ripened at much lower temperatures than was previously thought possible was a by-product of scientific work, a by-product that adds hundreds of thousands of dollars to the income of the cheese industry in Wisconsin yearly, and will do so as long as cheese is made.

The state of Wisconsin has invested much money in work that has been accomplished by Dean Russell during these twenty-four years of service as a bacteriologist and director of the work of the College of Agriculture and Experiment Station. The question of importance to-day is the soundness of the investment and the returns it brings. Those who are best acquainted with the matter would cease to worry about the high cost of living and of dying if they could feel that their investments were one half as sound and would bring them one thousandth part of the returns that the state of Wisconsin receives from the money it has invested in this man.

THE PRIESTLEY MEMORIAL OF THE AMERICAN CHEMICAL SOCIETY

By resolution of the council of the American Chemical Society adopted at its meeting in Urbana in April, 1916, the president was requested to appoint a committee to devise and carry out a plan for a suitable memorial to Joseph Priestley. After careful consideration of various plans, the members of the committee desire to present the following recommendations to the Society:

1. That a bust portrait of Joseph Preistley be secured, to be a copy of the best available portrait; that this be retained as the property of the American Chemical Society, but be deposited as a loan in the National Museum in Washington. Also,

2. That a gold medal be awarded at intervals of probably more than one year for superior achievement in chemical research; the award to carry with it the requirement that the recipient shall deliver an address before the general meeting of the society at the time of the presentation or at such other time and place as the council of the society may direct.

Carful inquiry has convinced the committee that, in order to carry out these plans, a fund of at least $2,000 should be secured. It is requested that subscriptions be sent to the chairman or to any member of the committee. Contributions of sums from $1.00 upwards are asked.

Joseph Priestley was born at Fieldhead in England in 1733. Although educated for the ministry, he became noted as a teacher and lecturer on natural science, and especially as an investigator in chemistry, devoting his attention largely to the study of gases. Persecuted and shunned as a result of popular prejudice for his theological views as a dissenter from the Established Church, he migrated to America in 1794 and settled with his family in Northumberland, Pennsylvania. Here he established a laboratory and continued his work as an investigator in chemistry.

While famous throughout Europe and in America for his historical and philosophical writings, for his important work on the History of Electricity, and many other contributions to scientific literature, he is more especially known to modern chemists for his researches on the chemistry of gases, which culminated in 1774 in the discovery of oxygen, described in his treatise entitled "Experiments and Observations on Different Kinds of Airs."

He continued in America to be a contributor to scientific and theological literature until his death in Northumberland in 1804.

On July 31, 1874, many of the leading chemists of America met near the grave of Joseph Priestley at Northumberland to honor the memory of the man who had discovered oxygen one hundred years before. In the account of the proceedings detailed in the *American Chemist* for 1874, we are told that a movement was there begun which led later to the establishment of the American Chemical Society.

And as the foundation of the American Chemical Society has been thus linked with the name of Joseph Priestley, it would seem proper that we should seek in some lasting way to commemorate his work as an investigator and philosopher and tireless searcher after truth.

It is earnestly hoped that the plans now proposed by the committee for a memorial will meet with approval and that we shall be able, by means of an adequate subscription fund, to render such honor as is due to the memory of John Priestley.

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Committee

SCIENTIFIC EVENTS

A STRUCTURE POSSIBLY FAVORABLE FOR OIL UNDER THE CENTRAL GREAT PLAINS

IN consideration of the present great interest in oil prospects in the Great Plains region, the United States Geological Survey, Department of the Interior, has prepared a report giving all available information regarding the structure of that region No oil or gas has been found in most of this wide area, but it contains several anticlines and domes like those which yield oil and gas in central Kansas, Oklahoma and Colorado, so that the conditions are encouraging for exploratory borings. Wells have been drilled at a number of places, but most of them have either been sunk where the structure was not favorable to the occurrence of oil or gas or have not been drilled deep enough to test all the strata.

The structure of the Central Great Plains north of latitude 37° has been investigated by geologist N H. Darton, who has prepared a map showing by contour lines the location and configuration of a number of promising anticlines and domes. One of these domes lies on the Nebraska-South Dakota line northeast of Chadron, its crest being on White River. It may continue southward under the great sand cover in Nebraska to join an anticline of moderate prominence which crosses the Republican Valley just above Cambridge, Nebr., and extends into the western part of Norton county, Kans.

A local dome of considerable height occurs in Hamilton county, Kans., its crest being 6 or 8 miles southwest of Syracuse. It is on the flank of the largest dome in the Central Great Plains, which arches up the strata in Baca, Las Animas, and Bent counties, Colo., and adjacent parts of northern New Mexico. Its crest is under the Mesa del Mayo, on the state line. A dike of igneous rock not far west of this place contains petroleum, which undoubtedly had its source in some of the uplifted strata.

A dome east of Fort Collins, into which a drill has penetrated 3,900 feet, also presents structure favorable for oil, and when the drill reaches the beds that yield oil near Boulder it may find in them a possible reservoir. There are some anticlines and domes in eastern South Dakota, but the strata above the granite and quartzite in that area are not thick enough to offer encouraging prospects.

A prominent anticline in Converse county, Wyo., with its crest east of Old Woman Creek, lifts an extensive series of sedimentary rocks not far southwest of the Black Hills. Another arch occurs on the west slope of these hills a few miles northwest of Moorcroft, and on its sides are oil springs from some underground source.

MEDICAL STUDENTS AND CONSCRIPTION

THE *Journal* of the American Medical Association has obtained information regarding the draft numbers and numerical order of call of medical students. There were all told 13,764 medical students enrolled during the last session, of whom 3,379 graduated, leaving 10,385, made up of 4,107 freshmen, 3,117 sophomores, 2,866 juniors, and 295 seniors who were not graduated. Tabulated statistics regarding 5,909 or 56.9 per cent. of all undergraduate medical students based on direct replies to a questionnaire are as follows:

Class	Total Replies	Total to be Drafted		First Call		Second Call		Later Calls		Age Exempt	Aliens	Enlisted
		No.	%	No.	%	No.	%	No.	%			
Freshmen..	2,016	1,579	78.3	412	26.0	283	20.3	884	55.9	384	14	39
Sophomores.	1,935	1,697	87.7	460	27.1	347	20.4	890	52.4	204	11	23
Juniors..	1,458	1,356	93.0	418	31.2	275	20.3	663	48.1	77	6	19
Seniors. ..	201	193	96.0	77	39.8	40	20.7	76	39.3	7	1	
Not stated	299	228	72.9	99	43.6	34	14.9	95	41.6	57		14
Totals..	5,909	5,053		1,466		979		2,608		729	32	95
Percentages..	.	85.5		29.0		19.4		51.6		12.4	0.5	1.6

While the table represents only a little more than 56 per cent. of the whole, it gives those interested an opportunity to estimate the effect of the draft on the different classes. As shown in the table, 5,053, or 85.5 per cent. of the students who have already replied, are subject to the draft, and of these 29 per cent. are included in the first call; 19.4 per cent. in the second call and 51.6 per cent. in later calls; 12.4 per cent. are exempt on account of age, 0.5 per cent. are aliens, and 1.6 per cent. have already enlisted. As will be noticed, 729 are exempt on account of age; of these 606 are under age, and 123 over the age limit. The *Journal* says that unless some arrangement is made, therefore, whereby these students are enabled to complete their medical training, classes in medical schools will be seriously depleted; the supply of physicians for the future will be seriously reduced, and this country will suffer from an error similar to that made in England and France where medical students were sent to the front. Furthermore, failure to exempt medical students from the draft will be a serious injustice to many, since a few months ago the Council of National Defense, with the apparent agreement of the War Department, urged medical students not to enlist in the Officers' Reserve Corps but to remain in college and complete their medical training. Had not that request been made, many students would have voluntarily enrolled in officers' training corps, where many of them would doubtless have been successful. Even though less than a third of the medical students of draft age will be included in the first call, a much larger proportion will be lost to the medical schools, since, in the absence of a definite understanding, many of the others will enlist voluntarily in the ranks, in ambulance corps or in officers' training corps. A definite decision on the part of the War Department relative to medical students is imperative. Unless such decision is made, not only will our civil hospitals lack adequate intern service, but the government will lose by the fact that those capable of skilled service will have been deflected to work which can be as well done by others.

PSYCHOPATHOLOGICAL EXAMINATION OF RECRUITS

ACCORDING to a press bulletin men of the National Guards of the various states and of the new draft army will be subjected to thorough mental examinations by expert neurologists and psychopathologists at the concentration camps before sailing to France, to weed out the mentally and nervously unfit, whom the experience of France, Britain and Germany shows have proved useless and a burden at the front. Not only are these examinations expected to weed out those whose nervous systems are broken down, and the feeble-minded or imbecile, but they will hinder the draft evaders from feigning nervousness or mental sickness. Not only will these expert neurologists and psychopathologists examine the men at the cantonments, but they will go to the front with the men and establish base hospitals adjacent to the orthopædic base hospitals.

Ten of the leading psychopathologists of the country have been selected for the starting of this branch of service. They are Dr. E. E. Southard, director of the psychopathic hospital of Boston; Dr. Robert M. Yerkes, professor of comparative psychology at Harvard University; Dr. August Hoch, director of the psychiatric institute, New York City; Dr. Adolf Meyer, director of the Phipps Psychiatric Institute, Baltimore; Dr. Albert M. Barrett, director of the State Psychopathic Hospital, Ann Arbor, Mich.; Dr. William A. White, superintendent of the Government Hospital for the Insane, Washington, D. C.; Dr. William E. Fernald, superintendent of the State School for the Feeble Minded at Waverley, Mass.; Dr. Thomas W. Salmon, medical director of the National Committee for Mental Hygiene of New York City, who has gone to England for observation; Dr. Joseph P. Collins, of the New York Neurological Institute, New York City, and Dr. T. H. Weisenburg, president of the American Neurological Association of Philadelphia.

There are five clinics where leading specialists and doctors are preparing for the work. They have been assigned by the government for special teaching in neurology and pschiatry for commissioned men in the Medical Reserve Corps. The courses of six weeks' duration, the first course just being completed, are being given at the following clinics: The Psychopathic Hospital, Boston; Phipps Psychiatric Clinic, Baltimore; State Psychopathic Hospital, Ann Arbor, Mich.; the Neurological Institute, New York City, and the Psychiatric Institute, Ward's Island, New York.

THIRD NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES

THE third national exhibition of chemical industries will be held in the Grand Central Palace, New York City, during the week of September 24. Many of the exhibits will have to do with the uses of chemistry in the making of war materials, and there will be a special section devoted to the South which will be known as the Southern Opportunity Section. Dr. Charles H. Herty, chairman of the advisory committee of the exposition, will deliver the opening address on Monday, September 24, at two o'clock. Professor Julius Stieglitz, president of the American Chemical Society; Dr. Colin G. Fink, president of the American Electro-Chemical Society, and Dr. G. W. Thompson, president of the American Institute of Chemical Engineers, will speak before different sections of the convention. Other speakers on the program include W. S. Kies, vice-president of the National City Bank, who will talk upon "The Development of Export Trade with South America"; Professor Marston Taylor Bogert, chairman of the chemistry committee of the National Council, whose subject will be "The operation and work of the National Research Council for the national weal," and Dr. L. H. Baekeland, of the Naval Counsulting Board, on "The future of the American chemical industry."

One day will be devoted to a symposium upon the national resources as opportunities for chemical industries, and among the speakers will be: Mr. C. H. Crawford, assistant to president of Nashville, Chattanooga & St. Louis Ry.; Mr. V. V. Kelsey, chemist-industrial agent, Carolina, Clinchfield & Ohio Ry.; Dr. E. A. Schubert, mineralogist-geologist, Norfork & Western Railway; Dr. T. P. Maynard, mineralogist-geologist, Central of Georgia Ry. and Atlantic Coast Line Ry.; Dr. J. H. Watkins, geologist, Southern Railway.

The motion-picture program will be one of wide interest. The American Cyanamid Company and General Electric Company have already arranged to supply their films. The Bureau of Commercial Economics at Washington will supply many toward completing the range of industrial films. At the last exposition two floors of the big building were occupied by 187 exhibitors. This year three floors, possibly more, will be occupied. Already the list of exhibitors contains 250 names of companies entering every field of industry.

SCIENTIFIC NOTES AND NEWS

Surgeon-General Gorgas, Dr. Franklin H. Martin, head of the Medical Bureau of the Council of National Defense, and their staffs, and a large number of army and reserve medical officers visited on August 12 the Rockefeller Institute for Medical Research, where they saw demonstrations of the medical and surgical practises which the institute has developed.

Surgeon-General Gorgas, of the army, reorganizing the Veterinary Corps, has selected the following veterinary surgeons as an advisory board: Dr. C. J. Marshall, Pennsylvania; Dr. David S. White, dean of the college of veterinary medicine, Ohio State University, Columbus; Dr. Louis A. Klein, dean of the school of veterinary medicine, University of Pennsylvania; Dr. V. A. Moore, dean of the New York state veterinary college, Cornell University, and Dr. John R. Mohler, assistant chief of the Bureau of Animal Industry, Washington.

A research committee to cooperate with the National Research Council has been appointed at Brown University, including from the faculty Professors Carl Barus, Albert D. Mead, Roland G. D. Richardson, John E. Bucher and Frederic P. Gorham; from the university corporation, Chancellor Arnold B. Chace and Edwin Farnham Greene, treasurer of the Pacific Mills; from the alumni, J. B. F. Herreshoff, of the Nichols Chemical Company; Charles V. Chapin, M.D., of the Providence Board of Health; John C. Hebden, of the Federal Dye Stuffs Corporation, and Frank E. Winsor, of Providence. The committee will prepare a survey of research already in progress at Brown University, and assist in a national census of research work in the United States. It will endeavor to broaden the conception of scientific research, to cooperate with industrial corporations, and to establish research fellowships so as to train promising young men and women for important positions in manufacture and in the government service.

Professor William Campbell, of Columbia University, New York, is serving as consulting metallographist at the New York navy yard.

Dr. Hardee Chambliss, chemical director of the Commercial Acid Company of St. Louis, has been commissioned major in the ordnance section of the Officers' Reserve Corps.

The British Fuel Research Board, with the sanction of the Committee of the Privy Council for Scientific and Industrial Research, has appointed a committee of inquiry into the utilization of Irish peat deposits. The following appointments have been made to the committee: Sir John Purser Griffith (chairman), Professor Hugh Ryan, Professor Sydney Young, Mr. George Fletcher and Professor Pierce Purcell (secretary).

It is stated in *Nature* that grants have been made out of the Dixon fund of the University of London for the year 1917–18 as follows: £25, Mr. Nilratan Dhar, for research on temperature coefficients of chemical reactions; £30, Mr. H. R. Nettleton, for researches on the measurement of the Thomson effect in wires; £20, Dr. D. Ellis, towards the cost of publication of a book on "Iron Bacteria"; £100, Mr. Birbal Sahni, to enable him to carry out botanical investigations at Cambridge.

The Asiatic Society of Bengal has awarded the Barclay memorial medal to Col. H. H. Godwin-Austen, for his work in biology.

Dr. Edward G. Birge has resigned as director of the state bacteriologic laboratory at Jacksonville, Fla., and has been succeeded by Dr. Burdett L. Arms, Montgomery, chief bacteriologist of the Alabama State Board of Health.

Dr. Edward S. Godfrey, Jr., has resigned as director of the Illinois Bureau of Communicable Diseases of the State Board of Health, to accept a position in the sanitary department of the New York State Department of Health. He has been assigned to the district comprising Albany and Rensselaer counties.

THE Ellen H. Richards Memorial Fellowship, offered jointly by the trustees of the Memorial Fund and the University of Chicago, has been awarded to Minna C. Denton, B.S. and A.M. (Michigan). Miss Denton's teaching experience at Milwaukee-Downer College, Lewis Institute and Ohio State University has been supplemented with recent work as fellow in physiology of the University of Chicago. She is at present at work on the alterations in nutritive value of vegetable foods due to boiling and canning. The fellowship carries a stipend of $500 and tuition fees for the year 1917–18.

ASSISTANT PROFESSOR J. WENDELL BAILEY, of the General Science School of the Mississippi Agricultural and Mechanical College, has accepted an appointment with the U. S. Department of Agriculture, Bureau of Entomology, and is engaged in research work on insects affecting cereal and forage crops. He is now at Tempe, Arizona, in the irrigated section of the Salt River Valley.

DR. W. S. MILLER, professor of anatomy in the University of Wisconsin, recently delivered an address on "The architecture of the lung," before the faculty and students of the graduate summer quarter in medicine of the University of Illinois.

WE learn from the *Journal* of the American Medical Association that a large party of medical men and others who were delegates from the medical faculty of the University of Buenos Aires and other medical organizations of Argentina sailed to Rio de Janeiro recently to visit the profession at Rio. The party bore with them a large bronze tablet to be placed in the Bacteriologic Institute founded and directed by Oswaldo Cruz. It represents Argentine medical science, humanity and hygiene decorating with laurel the memorial inscription to the great hygienist who cleared Rio de Janeiro of yellow fever. The physicians were welcomed by the authorities as guests of the nation during their stay. They also presented the Museum of Natural History with plaster casts of the five skulls on which F. Ameghino based his anthropologic theory of the fossil American man.

THE geology and paleontology committee of the National Research Council has passed the following resolution:

> We desire to record our keen sense of loss in the death of our colleague, Dr. William Bullock Clark.
>
> Since the organization of this committee, six months ago, Dr. Clark's extraordinary executive ability has been devoted without reserve to its aims, and the work which he organized, as chairman of the important subcommittee on roads and road materials, has proceeded with celerity and accuracy over the entire Atlantic seaboard from Maine to Florida.
>
> He gave an invaluable service to his country with intense devotion, and we feel that he has made the supreme sacrifice.

THE death is announced at the age of seventy-four years of Robert Helmert, professor in the University of Berlin and director of the Geodetic Institute.

DR. THEODOR KOCHER, professor of surgery at the University of Berne, has died at the age of seventy-six years. Dr. Kocher was distinguished for his work on goiter and in other directions The Nobel prize which he received in 1909 he gave to the University of Berne for medical research.

M. PAUL HARIOT, author of works on fungi and algae, and for many years in practical charge of the collections of the lower plants at the Muséum d'Histoire Naturelle of Paris, died on July 5, from diabetic complications. The broad-minded liberality and tireless patience with which M. Hariot always placed the treasures of his department of the museum at the service of the scientific men of the world will long be held in grateful remembrance by a considerable number of American botanists.

PROFESSOR J. H. BARNES, agricultural chemist to the government of India, and late principal of the Government College of Agriculture, Lyallpur, Punjab, died in India on June 2.

Mr. Stanley Baldwin has stated in the House of Commons that the question of the suspension of the issue of the *Kew Bulletin* had been considered by the Select Committee on Publications and Debates' Reports, and that it was decided to recommend that the *Bulletin* should be continued, but with due regard to economy. Certain classes of information, though doubtless of scientific interest, can, it is thought, be postponed without detriment to the welfare of the state.

UNIVERSITY AND EDUCATIONAL NEWS

According to the *Experiment Station Record* appropriations made by the state legislature for the South Dakota College and Station include $80,000 for an armory, $100,000 for the completion of Agricultural Hall, $10,000 for a health laboratory, $10,000 for the manufacture of hog cholera serum, $20,000 for a fireproof stock judging pavilion, $3,000 for a poultry department, $10,000 for the purchase of pure bred live stock, and $5,000 for feeding experiments with live stock. This is the first appropriation made by the state for experimental work.

Professor E. V. McCollum has resigned his position as professor of agricultural chemistry at the University of Wisconsin, to take charge of the department of chemistry of the new school of hygiene and public health, which the Rockefeller Foundation has established in connection with the medical school of the Johns Hopkins University.

Professor Frank C. Becht, assistant professor of pharmacology in the University of Chicago, has been appointed professor and head of the department of pharmacology in Northwestern University Medical School, succeeding Professor Hugh McGuigan, who has become professor of pharmacology in the University of Illinois.

Dr. A. E. Lambert has been appointed professor of histology and embryology in the college of medicine of the University of Vermont. Dr. M. W. Hunter, instructor in medicine, has resigned and Dr. Fred E. Clark, assistant professor of pathology, has received a year's leave of absence.

Professor H. Halperin, of Vanderbilt University, has been appointed assistant professor of mathematics at the University of Arkansas.

Dr. Percy Kendall Holmes, of the University of Cincinnati, has been appointed director of physical education in Ohio Wesleyan University.

Mr. G. Gerald Stoney has been appointed professor of mechanical engineering in the Manchester School of Technology.

M. Lucien Poincaré, director of higher education in France, has been appointed vice-rector of the University of Paris, in succession to M. Liard.

M. Moureu, member of the French Institute, professor in the school of pharmacy and director of the editorial board of the *Revue Scientifique*, has been appointed professor of organic chemistry in the Collège de France.

DISCUSSION AND CORRESPONDENCE

THE COST OF ROAST PIG

Charles Lamb, in his "Dissertation on Roast Pig" relates that, according to an ancient manuscript, the hut of a Chinese swineherd taking fire, a litter of newly farrowed pigs perished in the conflagration. Seeking to find if life remained in any of them, the swineherd burned his fingers on the hot body of a pig. To alleviate the pain he naturally put his fingers into his mouth and so discovered the delicious flavor of roast pig. The taste spread rapidly and shortly all China was ablaze with burning pig pens sacrificed for the sake of producing the new delicacy.

In the food crisis with which the world is apparently confronted, roast pig may stand for the supply of animal products in general, and our methods for producing them hitherto have not been altogether unlike that for roasting pigs attributed to the Chinese. At this juncture, it seems pertinent to inquire whether our practises in this respect do not need to be modified so as to contribute more effectively to the feeding of the nations.

Roast pig, to those who like it, is not only a delicacy but a valuable article of diet, but nevertheless, as the Chinese presumably came to realize, it is possible to pay too high a price for it, and while a proposal to restrict rather than to promote meat production in the present crisis may appear both irrational and unpatriotic it may nevertheless be in the interest of true food economy.

This is because of one cardinal fact which the advocates of the multiplication of farm live stock, the prohibition of the slaughter of young animals, etc., overlook. That fact is that not only must the meat or milk producing animal be fed (and even this appears to be forgotten at times) but that the conversion of feed into animal products is a process of relatively low efficiency.

Man needs food primarily as fuel to supply the energy for his activities and secondarily to furnish the repair material (protein) for the bodily machinery. An active adult requires daily some 4,000 calories of energy, the amount varying more or less according to the amount of physical work done. He can get this energy from either vegetable or animal products. He may make his wheat or corn into bread and use that bread as body fuel, or he may feed them to animals and consume the resulting meat or milk. The latter are excellent body fuels and are desirable ingredients of the dietary but their production from grains is a very wasteful process. It may be roughly estimated that about 24 per cent. of the energy of grain is recovered for human consumption in pork, about 18 per cent. in milk and only about 3.5 per cent. in beef and mutton. In other words, the farmer who feeds bread grains to his stock is unconsciously imitating the Chinese method and is burning up 75 to 97 per cent. of them in order to produce for us a small residue of roast pig, and so is diminishing the total stock of human food.

Now most of us like roast pig and its production in this way has doubtless been economically justifiable in years past when our food supply was vastly in excess of our needs. To-day the case is different. No longer can we continue to take the children's bread and cast it to the brutes. If our meat supply is to be maintained or increased it must be in some other way. All the edible products which the farmer's acres can yield are needed for human consumption. The task of the stock feeder must be to utilize through his skill and knowledge the inedible products of the farm and factory such as hay, corn stalks, straw, bran, brewers' and distillers' grains, gluten feed, and the like, and to make at least a fraction of them available for man's use. In so doing he will be really adding to the food supply and will be rendering a great public sevice. Rather than seek to stimulate live stock husbandry the ideal should be to adjust it to the limits set by the available supply of forage crops and by-product feeding stuffs while, on the other hand, utilizing these to the greatest practicable extent, because in this way we save some of what would otherwise be a total loss. In particular the recommendation to raise more hogs seems to call for some qualification. It is indeed true, as several have pointed out, that the hog can make more pounds of edible meat from a given amount of concentrated feed than any other class of live stock. The point is that with the present demand for bread grains we can not afford the cost of the conversion. So far as hogs can be raised on forage and by-products the recommendation is sound, and this animal can play an important part in utilizing domestic and other wastes, but the hog is the great competitor of man for the higher grades of food and in swine husbandry as ordinarily conducted we are in danger of paying too much for our roast pig. Cattle and sheep, on the other hand, although less efficient as converters, can utilize products which man can not use and save some of their potential value as human food. From this point of view, as well as on account of the importance of milk to infants and invalids, the high economy of food production by the dairy cow deserves careful consideration, although of course the large labor requirement is a counter-balancing factor.

At any rate, it is clear that at the present time enthusiastic but ill considered "booming" of live stock production may do more harm than good. If it is desirable to restrict or prohibit the production of alcohol from grain or potatoes on the ground that it involves a waste of food value, the same reason calls for restriction of the burning-up of these materials to produce roast pig. This means, of course, a limited meat supply. To some of us this may seem a hardship. Meat, however, is by no means the essential that we have been wont to suppose and partial deprivation of it is not inconsistent with high bodily efficiency. Certainly no patriotic citizen would wish to insist on his customary allowance of roast pig at the cost of the food supply of his brothers in the trenches.

H. P. Armsby

State College, Pa.,
June, 1917

A NEW CONTRIBUTION TO AMERICAN GEOLOGY

Under the heading "Work going on at Kilauea Volcano" there was published in Science of September 12, 1913, an account from Hawaii by Mr. Geo. Carroll Curtis, of the field work, cirkut and kite camera surveys being conducted in the great active crater, in connection with the construction of a naturalistic model for the geological department of Harvard University.

After four years of continuous effort this work has been completed and installed in the university museum. While the size and time required distinguish it, the principles it involves of faithful and expressive reproduction of the earth surface is of special significance, as it seems to mark a distinct progress in the complex subject of representing our earth in true relief and character. A single glance at the great model is convincing, for in looking upon this vast collection of accurate data, one receives the impression that he is viewing the outdoor field itself! The model looks like the actual ground because it has been made like it, an immense amount of information never before collected having been incorporated from the special surveys. This is a signal triumph in the truthful interpretation of a splendid type of geological structure such as Kilauea presents. It clearly indicates the novel and broad interest which awaits the earth sciences in the reproduction of their museum natural history specimens through the medium of serious work in land relief.

The longest time previously given to any work we have had of this nature, was two years, in the naturalistic reproduction of the coral island Bora Bora,[1] under the instigation of Alexander Agassiz. It was made to illustrate the typical "high coral island." This work, completed in 1907, was the first in the land where the necessary photographic survey and special field work were employed to truthfully reproduce a land form type, and marked the introduction of the naturalistic or landscape model in American exhibition. The character of the work was illustrated by the photographs made from it, bearing a surprising resemblance to those taken on the actual ground, a thing previously unlooked for in our land reliefs. This unique contribution to the progress of earth science is still considered the most complete exposition of a coral island known, and as the pioneer in naturalistic land relief (the completest expression which science and art can give of the earth's surface) will always remain a most significant piece of work.

The Kilauea model represents the progress of the intervening decade, in the new and developing art of the accurate reproduction of the surface of the planet, and is the culmination of the unique experience which has come through a training in both geology and in art, which Mr. Curtis has given to this profound though much misrepresented work of earth relief. Against precedent he has attempted to make a profession rather than a business of a work which calls for treatment adequate to the dignity of natural science. Valuable as may be the individual models to which Curtis has given so much time and study, it is in the establishment of a standard more in keeping with that called for by the natural sciences and by the meaning and interest of the face of our earth, that his most significant achievement lies. That this standard is to-day probably second to none is to be seen in the Kilauea model which presents several important innovations in the development of land relief, including the application of cirkut panorama and aerial photography and the cycloramic background.

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[1] Darwin, "Structure and Distribution of Coral Reefs," p. 4.

The Kilauea undertaking marks the advent of the American geologist into the work most complete and effective of any known for representation of the immense forms with which he deals. Some conception of what this subject, calling for the best that modern science and art can offer, has in store, may be had from statements of those who have visited the active volcano and maintain that a better comprehension of the huge crater may be obtained from the model in Cambridge than in Hawaii itself, owing to the vast dimensions of the Kilauea region. What is yet in store for the earth sciences through the naturalistic reproduction in relief of remaining great types of land form, should give some measure of the value of this contribution.

Robert W. Sayles.

Geological Section,
Harvard University Museum

BOTRYTIS AND SCLEROTINIA

Connection has recently been established between an apparently undescribed species of *Sclerotinia* occurring in woods in the upper end of Van Cortlandt Park on the rootstocks of wild geranium and a species of *Botrytis* occurring on the roots and rootstocks of the same host. The field observations were made by the writer and the culture work was conducted in the New York Botanical Garden by Professor W. T. Horne. A joint paper will be offered on the subject in connection with the celebration of the fiftieth anniversary of the Torrey Botanical Club this fall. As it will be several months before this paper can appear in print, it was thought advisable to call attention to the facts at this time. While connection between *Botrytis* and *Sclerotinia* has been claimed by DeBary and predicted by more recent workers, this is one of the first and possibly the first case in which the connection has been definitely established by culture experiments.

Fred J. Seaver

The New York Botanical Garden

QUOTATIONS

A BRITISH REPORT ON INDUSTRIAL RESEARCH IN AMERICA

The Advisory Council for Scientific and Industrial Research has issued the first of a series of papers in which, under the title of Science and Industry, it intends publishing information of value to manufacturers. The intention was announced in the report of the Committee of the Privy Council, of which an account appeared in these columns; and the present instalment by Mr. A. P. M. Fleming, of the British Westinghouse Company, on industrial research in the United States, is so full of information and practical suggestion that engineers will learn with regret that there is little prospect of further instalments appearing during the war.

The paper differs from much that issues from the Stationery Office in being essentially a practical work, not loaded with statistics and theoretical considerations. It is a plain statement of facts and practical suggestions very important to industry, set out for British manufacturers by one of their own body in such a way that what it describes and what it suggests can readily be understood; it is illustrated by 85 half-page or full-page blocks, and published—at the public cost—at the price of 1 s. No appreciable expense either of time or brain-stuff or money stands between the message of the volume and the public for whom it is meant; and while there is no point in summarizing what can be easily acquired and digested, some of its facts and the consequences that they suggest are worth consideration.

The modern tendency of American manufacture to research may perhaps be seen most strikingly in what is being done by manufacturing and similar corporations themselves. Examples are to be found alike in the mechanical, electrical, and chemical industries, and are on every variety of scale, up to the £30,000 per year to which the Eastman Kodak Company devotes something under 1 per cent. of its profits, and the £80,000 to £100,000 a year spent by the General Electric Company of Schenectady. Mr. Fleming gives particulars of what is being done by each of some twenty corporations, but the list could easily be made very much longer. Most of these laboratories have sprung up in quite recent years; and their number is constantly increasing. The increase is not merely in number. It is as remarkable in its growing breadth. The laboratories of these firms undertake not merely the routine of testing of materials and products and the more or less empirical adventures after new products that was formerly the business of a works' laboratory. At the one end of the scale they carry out experiments on the discovery of new products and the elaboration of new designs into the full manufacturing scale, and the laboratory supplies the needs of the market as if it were itself a works, until they outgrow the capacity of its plant and call for a new works of their own. At the other end of the scale they undertake inquiries into questions of pure science, of the solution of which no one can see any industrial application. They keep men investigating such problems constantly and perseveringly, and give them admirably equipped laboratories for the purpose. This sort of thing is being done in works after works, and every year adds to their number and the elaboration of their equipment. All the time, in spite of the enormous sums that are being spent on what at first sight is not only unproductive work, but work which tends to subordinate the wholesome rule of practise to the fantastic and costly demands of laboratories, the thing pays. The fact that the habit has grown so far is good *prima-facie* evidence that it must pay, for American business houses do not fling good money after bad. But there is no need to depend on inference or *prima-facie* evidence. The individual experience of those who have tried it shows that in fact it has paid, and the air in America is thick with plans to extend the practise of applying science to help industry; for great as is the extent of what has been done already, it is only a tiny fraction of what in American industry there is still room and the intention to do.

Side by side with these corporations and firms three groups of institutions are working to the same ends. Mr. Fleming quotes a dozen or more separate industries with their trade associations, each of which is undertaking research for the common benefit of their members; sometimes in their own common research laboratories, sometimes in those of their members, sometimes through university or the Bureau of Standards staffs. An excellent instance of an important trade of which all members, great as well as small, have gained greatly by research work communicated to all alike, is that of the canners. The Canners' Association spends some £6,000 or £7,000 a year on its central laboratory, besides a good deal more on work done in the factories of individual members; and it is considered that the largest members have as much interest as the small in the results being made common to all, because the risk of the whole trade being discredited by imperfect production is thus minimized. Over a dozen universities and colleges, again, are now running laboratories devoted not only to investigations in pure science which may ultimately find a practical application, but to industrial researches for which the application is waiting as soon as the solution of the problems is found. In many instances such work is done not on the strength of foundations, but at the request and expense and for the benefit of commercial firms and other industrial bodies, such as railway companies.—London *Times*.

SCIENTIFIC BOOKS

Use of Mean Sea Level as the Datum for Elevations. (Special Publication No. 41.) By E. LESTER JONES, Superintendent, U. S. Coast and Geodetic Survey, Washington, Government Printing Office. 1917.

This pamphlet presents a very strong case in favor of the adoption of a single datum for the elevations of the country in order to eliminate the confusion which results from the employment of arbitrary planes of reference.

There is scarcely any surveying or civil engineering which does not require that differences in elevation be determined by spirit leveling and in nearly all cases the absolute elevation of the bench marks above some plane of reference or datum is determined. Efficiency in operation frequently depends upon the datum selected. There are many other branches of science besides that of engineering in which absolute elevations are needed.

The selection of a fundamental datum is a matter of great importance. Only slight consideration leads one to conclude that the ideal datum for a nation is one which may be established at many places. The only one of this kind is mean sea level.

Mean sea level may be established within a very small fraction of a foot by continuous tidal observations for at least a year. It has been found from precise leveling observations that mean sea level, as established at different points on the open coasts, is at all such points in the same equipotential surface; that is, if there were no resistance of the water and wind to the movement of an object floating on the ocean, the object could be moved from one point on the coast to another without performing any work—there would be no lifting necessary. While this statement may not be absolutely true, yet it is so nearly the case that for all engineering and surveying purposes it may be accepted as rigidly true.

Mean sea level is used exclusively in the work of the Coast and Geodetic Survey and the U. S. Geological Survey. It is used to a certain extent by many other engineering bureaus of the government.

In December, 1916, the Coast and Geodetic Survey sent the following letter, or one similar to it, to the chief engineers of most of the large cities of the country, to the State Engineer of each state, and to the chief engineer of each of about 150 railroads in the United States:

> As you know, one of the important questions of the United States Coast and Geodetic Survey is the extension over the country of a network of precise leveling which will give elevations of great accuracy, based upon mean sea level.
>
> We believe that this precise leveling is essential in the surveying and engineering work done in this country by various public and private agencies. The network will enable engineers to use the sea-level datum on new projects and to reduce to this datum existing elevations referred to arbitrary datums. We believe that this country should eventually have but one datum, in order that all engineering and surveying work may be easily coordinated. We believe also, that the presence of various datums leads to much confusion and waste.
>
> In order that we may get into closer touch with the needs of the engineering profession, I should be glad if you will let me know to what extent your state is basing the elevations of its road and other surveys and engineering works upon mean sea level; also whether the use of various arbitrary datums by counties, cities and private organizations within your state is a serious matter in the industrial development of your state.

Replies were received from many of the engineers to whom the above letter was written. The opinions expressed were almost unanimously in favor of the adoption of mean sea level as the datum for elevations.

The pamphlet under discussion contains quotations from many of the letters received by the Survey. One of the quotations, typical of most of them, reads:

> So far as our experience has taught us there can be no question as to the desirability of a universal datum plane, and I think there can be no doubt in the minds of engineers engaged in municipal work that mean sea level is the only logical datum to adopt.
>
> In your advocacy of an extension of such bench marks you deserve the support and cooperation of every engineer in the country.

Another reads:

> We agree with you that it would be very valuable to the state if a system of levels could be established, and believe that such will need to be done in the near future in order to correlate the drainage, highway and other engineering work in the state.

It is realized by the members of the Coast and Geodetic Survey that much of the confusion in datums which now exist, is due to the fact that the precise level net of the United States was not extended in the past as rapidly as it should have been. It, of course, was impossible, or rather impracticable, to extend a precise level net into areas through which railroads had not been run, for the expense would have been prohibitive. It may be that the Survey did not fully realize the necessity for having all engineering and surveying work on the same datum, but in recent years it has become fully alive to the necessity of having a single datum for the entire country, and it is consequently extending its precise leveling net as rapidly as funds available will permit.

While it is of value to the nation for various organizations and individuals to adopt and use mean sea-level datum for their elevations, the country will benefit still more if each organization doing extensive leveling will publish in pamphlet form the elevations and descriptions of the bench marks they may establish in order that other organizations and individuals may properly coordinate their levels. Engineers are urged also to use substantial bench marks in order that future work may be benefited by their preservation.

The amount of precise leveling which should be done by the federal government can not be foretold. It must depend upon the needs of the various organizations and individuals using the results. After a certain development of the precise level net which appears now to be absolutely necessary, the rapidity with which further extensions are made should depend upon the development of the country. But such further extensions should precede rather than follow such development, as is proved by the unfortunate condition of affairs in much of our engineering and surveying work, due to lack of precise elevations in the past, when such work was inaugurated.

This paper on mean sea level should, and no doubt will, do much good in furthering the universal adoption of mean sea level as the reference surface for all elevations.

The publication of such pamphlets by government organizations is to be commended, for they present facts to the public in an effective way which may otherwise be buried for years in valuable but more cumbersome government reports with which all of us are more or less familiar. WILLIAM BOWIE

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

THE sixth number of volume 3 of the *Proceedings of the National Academy of Sciences* contains the following articles:

The stark effect in helium and neon: HARRY NYQUIST, Sloane Laboratory, Yale University. An improvement of Lo Surdo's method is applied.

New analyses of echinoderms: F. W. CLARKE and R. M. KAMM, United States Geological Survey, Washington. A progressive enrichment in magnesia, following increase of temperature, is unmistakable.

On utilizing the facts of juvenile promise and family history in awarding naval commissions to untried men: C. B. DAVENPORT, Station for Experimental Evolution, Carnegie Institution of Washington. A study with family charts of a number of naval officers.

The triplet series of radium: GLADYS A. ANSLOW and JANET T. HOWELL, Department of Physics, Smith College.

The measurement of small angles by displacement interferometry: CARL BARUS, Department of Physics, Brown University.

Mechanisms that defend the body from poliomyelitic infection, (a) external or extranervous, (b) internal or nervous: SIMON FLEXNER, Rockefeller Institute for Medical Research. A report upon the results of recent experiments.

The occurrence of harmonics in the infrared absorption spectra of diatomic gases: JAMES B. BRINSMADE and EDWIN C. KEMBLE, Jefferson Physical Laboratory, Harvard University. The discontinuities in the structure of these bands force the conclusion that the angular velocities are distributed among the molecules in the discontinuous manner predicted by the older form of the quantum theory, and the proved existence of harmonics is almost equally good evidence that the vibrational energy of the molecules is distributed in the same manner.

The loss in energy of Wehnelt cathodes by electron emission: W. WILSON, Research Laboratories of the American Telephone and Telegraph Company and of the Western Electric Company. The emission of the electrons from Wehnelt cathodes is due to a similar mechanism to that causing the emission from heated pure metals.

Daily variations of water and dry matter in the leaves of corn and the sorghums: EDWIN C. MILLER, Kansas Agricultural Experiment Station. Under the conditions of these experiments the sorghums, and more particularly milo, absorb water from the soil and transport it to the leaves more rapidly in proportion to the loss of water from the plant than does corn, and thus the sorghums can produce more dry matter for each unit of leaf area under severe climatic conditions than can the corn plant.

Note on complementary fresnellian fringes. CARL BARUS, Department of Physics, Brown University.

The displacement interferometry of long distances: CARL BARUS, Department of Physics, Brown University. In preceding notes two methods for measuring small angles have been suggested. Application is here made to the determination of distances and is shown that an object at about a mile should be located to about thirty feet.

National Research Council: Meetings of the Executive Committeee and the Joint Meeting of the Executive, Military, and Engineering Committees. Report of the Astronomy Committee.

EDWIN BIDWELL WILSON

MASS. INSTITUTE OF TECHNOLOGY,
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SPECIAL ARTICLES

INTRA-VITAM COLOR REACTIONS

WE have slowly come to have great confidence in the specificity of certain physiological actions. We introduce into an organism certain substances, and definite results follow; but about the only thing we know in the matter is that the results follow with certainty. In such cases, if only we could see what it is that happens while it is happening, it seems certain that important advances would be made in our knowledge of nutrition, growth and decay—of physiology, pathology and medicine.

If substances giving color reactions in living tissues could be applied to small, transparent, varied and highly complex living organisms, under circumstances that would permit microscopic examination while the reactions are in progress, we might hope for more light on this exceedingly important subject. Experiments I have made lead to the belief that many of the conditions requisite for success in this line of investigation can be much more fully realized than hitherto by feeding colored substances, notably coal-tar dyes, to free-living nematodes.

These minute, transparent animals are comparatively highly organized; not only this, but also extremely varied in their mode of life. Some are exclusively vegetarian, others exclusively carnivorous, and others omnivorous. They constitute a group composed probably of hundreds of thousands of species, embodying an almost inconceivable number of kinds of physiological action. Their organs are enclosed in a thin transparent cuticle, and are strung out so as to make them unusually suitable for *intra-vitam* examination. Under slight pressure the nema flattens out more or less without losing its vitality sufficiently to preclude satisfactory *intra-vitam* examination under the highest powers of the microscope.

Observing certain precautions, I find that a great variety of coal-tar compounds and other colored compounds can be fed to nemas, apparently without interfering materially with their normal metabolism. I have had the best results by cumulative action, using small quantities of color dissolved in the medium in which the nema lived, and allowing the dye to act for days or weeks.

Not infrequently the dyes prove to be highly specific in their action. Only certain cells, or only definite parts of certain cells, exhibit visible reactions in the form of colorations. The results obtained by the use of any given dye may be quite varied. It is evident in many cases that the dye is digested and assimilated, thereby undergoing molecular changes by which it is converted into new compounds in a manner analogous to the processes exemplified in chemical laboratories devoted to the production of aniline dyes. Thus, a dye may give rise to several different colors, none of them like that of the dye itself, and all of them very likely due to new compounds. Often I have seen considerable evidence pointing to the conclusion that in some cases the dyes fed are converted into colorless compounds during the process of digestion (a reduction phenomenon), and these colorless compounds reconverted into colored substances after they arrive at certain destinations or conditions. The number of changes these "living laboratories" can ring on the molecular structure of a given dye must in some cases be very considerable. Two or more dyes fed simultaneously sometimes produce results more or less independent of each other. The spectacles are very brilliant.

Using these methods I have been able to demonstrate within the confines of a single cell the existence of an unsuspected number of kinds of "granules," manifestly playing different rôles. After the differences among these bodies have been shown in this way, it is sometimes possible to perceive corresponding morphological differences; but without the aid of the color reactions the differences would never have been suspected.

The main thing to bear in mind is that on the basis of our present more complete knowledge of the chemical and physical properties of coal-tar-derivatives these color reactions in living nemas may be made the index of physiological characters possessed by cells and their components. In view of the great variety of the known coal-tar derivatives, and the great variety of physiological activities exemplified in the free-living nemas, it seems to me a very reasonable hope that researches directed along this line will lead to important results, and that the nemas may become classical objects in cell and general physiology, as they have already become in sex physiology.

A new and rather extensive nomenclature will become necessary. It will be needful to distinguish between the results of *intra-vitam, intra-mortem* and *post-mortem* staining; for these three terms represent as many different phases in the chemical reactions that take place during the course of the experiments. As the cells lose vitality, new color reactions occur, and the death of the cell is followed by further equally marked changes in the reactions.

The cell elements I have mentioned vary in size, but most of them are exceedingly small, many so small that they are on the limits of visibility, using the very best instruments with the greatest skill and under the most favorable conditions. On the other hand, some of them are large enough so that they can be examined in considerable detail and their structures made out. Among them are the bodies currently referred to under the name mitochondria and other more or less synonymous words.

As it will be some time before we can establish a rational nomenclature for these numerous intracellular structures, it is desirable meanwhile to adopt terms that will permit intelligent discussion of our discoveries as they are made. While the principles underlying such a nomenclature are easily defined, it is by no means easy, in the present condition of things, to suggest suitable short and expressive roots to be used as a basis. There will be less liability of confusion if the names first employed relate to form, size and position rather than to function.

Investigations of this character are not unlikely to stimulate further research in connection with aniline derivatives. Present efforts are directed toward the discovery of dyes of greater or less permanency. Permanency, however, is of little moment in these investigations; what is of moment is the chemical composition and physical properties of the dyes. No doubt dyes of a greater range of composition can be produced if permanency be disregarded. Furthermore, as already hinted, colorless compounds may be used in intra-vitam work if in the course of the metabolism they are converted into colored compounds. The results of recent studies of dies as chemical indicators come into play, and give valuable evidence in determining acidity and alkalinity.

I am almost ready to express the opinion that a small army of investigators should be engaged on the problems opened up in this way. The equipment needed by the investigator is as follows: He must be a very good microscopist, versed in physiology, cytology and histology. He should be conversant with the chemistry of the coal-tar compounds, not so much from the viewpoint of the maker of dyes as from that of the broad-minded chemist, freed from the economic domination of the dye industry, for, as before remarked, fugitive dyes, and even colorless compounds, are possible factors in such investigations as are here under discussion. He should have a working knowledge of nemas.

ILLUMINATION

In order to distinguish with accuracy among *intra-vitam* color reactions it is necessary to be very particular about illumination. The most perfectly corrected lenses must be used, both as condenser and objective, and the light used must be as nearly white as possible. The best source of light known to me for these researches is bright sunlight reflected from a plane matte white reflector. The reflector should be several feet across, and placed at a distance from the microscope several times its own diameter. It should be universally adjustable, so that it can be set to reflect a maximum of light to the mirror of the microscope —all the better if heliostatic. A good surface for the screen is made by whitewashing a rather finely woven cotton cloth.

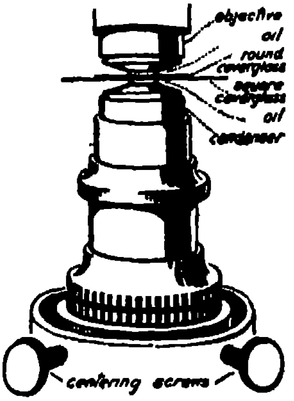

FIG. 1.

The best optical arrangement I have tried is the use of one apochromatic objective as a condenser for another apochromatic objective. I have been using with success a 2 mm. apochromatic as a condenser for a 2 mm. or 1.5 mm. apochromatic objective. These precautions are necessary if fine color distinctions are to be made with the greatest possible accuracy. If these precautions are taken it will be found that fine distinctions can be made with such precision as to dispel all doubt as to the existence, side by side, in the same cell of definite structures of varying character that it would otherwise be impossible or exceedingly difficult to distinguish from each other.

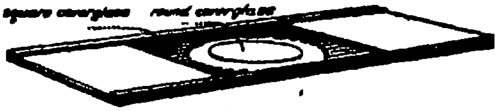

FIG. 2.

The use of an ordinary apochromatic objective as a condenser necessitates the use of a special object slide, consisting essentially of a carrier and two cover glasses. The object is mounted between the cover glasses. Such a slide is shown in the accompanying illustration. The substage of the microscope should have a centering arrangement and a rack and pinion or screw focusing adjustment. A little experience with an apparatus of this sort, in which all known precautions are taken to remove color from the optical system, leads one to distrust the ordinary Abbé substage condenser where fine distinctions are to be made between colors, especially if the colors are of similar character.

N. A. COBB

U. S. DEPARTMENT OF AGRICULTURE

THE AMERICAN CHEMICAL SOCIETY

DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

H. P. Talbot, *Chairman*

E. B. Millard, *Secretary*

The positive and negative specific heat of saturated vapors: F. P. SIBBEL. A vapor expanding from a temperature T to the temperature $T-1$ reversibly, yields the maximal work W due to the latent heat of vaporization H introduced at the higher temperature in accordance with the second law expressible in equivalent calories as

$$W = H\frac{T-(T-1)}{T} = \frac{H}{T} \text{ calories.}$$

This amount of work is in many cases greater than the difference in the total heat of the vapor L between the temperatures T and $T-1$ degrees absolute, viz., $L-L_e$ and in this case an amount of heat equal to $H/T=(L-L_e)$ must be added to maintain the vapor in a saturated condition, and it is *therefore* called the "negative specific heat" at the temperature T. If $L-L$ is greater than $\dot{H}/T$ the difference of heat must be added and it is then called "positive specific heat." The examples show that all the numerical values in this respect determined by Clausius on a somewhat different basis agree perfectly with those obtained after the above formula, which agreement, however, is not found with other results obtained by other authors on a similar basis, apparently due to errors of judgment so liable in the application of the calculus. Moreover, it is argued that instead of the heat quantity H/T which represents the net work when the expansion takes place in a reversible cycle, the heat quantity W_e representing the maximax work in reversible expansion should be used, which changes the values of positive and negative heat slightly.

The separation of erbium from yttrium: B. S. HOPKINS and EDWARD WICHERS. The erbium-yttrium material used in the investigation was obtained by fractional crystallization of the bromates. Methods recommended by Drossbach and Wirth could not be duplicated with the success obtained by these workers. Cobalticyanide precipitation as recommended by James, was found to give a good separation, but offered practical difficulties. Precipitation with sodium nitrite as used by Hopkins and Balke found to give a rapid separation when used with material which was predominantly yttrium.

A study of the ratio of Er_2O_3*:2* $ErCl_3$*:* C. W. BALKE and EDWARD WICHERS. A brief discussion of other ratios used in determining the atomic weights of the rare earth elements was given and the constancy of composition of the rare earth sulphates questioned. The method of applying the oxide-chloride ratio to erbium was described and data given which give an atomic weight approximately one unit higher than the present value.

A thermal study of some members of the system $PbO-SiO_2$*:* L. I. SHAW and B. H. BALL. Many mixtures of PbO and SiO_2 varying in composition from 40 per cent. to 90 per cent. PbO were melted in an electric furnace and the records of their thermal conduct plotted on time-temperature diagrams. (In some cases PbO_2 was used instead of PbO and its behavior is noted.) The significant temperatures of these graphs were then combined into a composite temperature and it was concluded that the system is a case of solids in solid solution. Two maxima corresponding to the composition $PbO-SiO_2$ and $2\ PbO-SiO_2$ were found and another $2\ PBO-5\ SiO_2$ was clearly indicated. Two eutectics are indicated, though the lower one may be a transition point of the one of the higher melting point. As noted by previous investigators, a transition point of SiO_2 was found at 540°-580° C. All mixes sintered at 690° ± 10° C.

A study of the change of conductivity with time in the system methyl alcohol-iodine-water: L. I. SHAW and JOHN P. TRICKEY. Conductivities of solutions of iodine in methyl alcohol of various boiling points have been measured. It was found that the conductivity increased much more rapidly in the case of the solutions in alcohol of higher boiling points; also, that the conductivity reached a higher value in the case of the solutions from the higher boiling point alcohols. It was suggested that this was probably due to the water content of the alcohol. It was found that a smooth curve could be drawn through the points at which the conductivity of the various solutions became constant. Suggestions as to the probable reaction were given.

The solubility of pure radium sulfate: S. C. LIND, C. F. WHITTEMORE and J. E. UNDERWOOD. The solubility of $RaSO_4$ in water and other solutions is of practical interest since all processes for the recovery of radium from its ores involve, at some stage, the precipitation of radium together with barium as sulfate.

Studies in pseudo-isotopy—Part I: S. C. LIND. Experiments of the author and others have shown that when radium and barium are partially precipitated from a solution containing a mixture of the two, no change in relative concentration takes place. This is true for sulfate, oxolate, carbonate, and perhaps all other difficulty soluble salts, and bears an exact analogy to the inseparability of the isotopic elements. The fact that radium and barium are only *pseudo*-isotopic, however, is shown from the great divergence of their atomic numbers, and their ready separation by recrystallization of the chlorides or bromides. It has been shown in the preceding paper that the assumption of identical solubility of $RaSO_4$ and $BaSO_4$ in analogy to their pseudo-isotopic action in precipitation reactions, is far from the truth. Conversely, this must raise the question, from the purely experimental side, as to the truth of the assumption generally made of identical solubility of true isotopes.

SCIENCE

Friday, August 24, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE IMPORTANCE OF MOLD ACTION IN SOILS[1]

The development of soil bacteriology during the last decade has been truly remarkable. Many fundamental problems connected with the occurrence and activities of bacteria in soils have been attacked and considerable progress has been made toward their solution. While much work still remains to be done along this line, results already secured show, in a rather definite way, the importance of bacterial action in soils from the fertility standpoint.

According to recent investigations, however, bacteria are not the only microorganisms which exert an influence on soil fertility. Molds, protozoa and algæ have been found quite commonly, and evidently their action, especially that of molds, must also be considered in determining the crop-producing power of soils. The subject of microorganic life in the soil has, therefore, been considerably broadened and complicated.

The occurrence of molds in soils has been noted many times in the past in connection with bacteriological and other studies and various investigations have dealt in a more or less general way with the action of these organisms. It is only within the last year, however, that an attempt has been made in a logical and comprehensive manner to study the occurrence, distribution and activities of molds in soils, and to solve some of the fundamental problems which arise in connection with the growth of these organisms. The results secured at the New Jersey Agricultural Experiment Station,”[4, 2] not only furnish a basis upon which future experiments may rest, but they also indicate quite distinctly that the growth of molds in the soil may be of great significance.

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[1] Paper presented at the meeting of the Society of American Bacteriologists, at New Haven, Conn., December 27, 1916.

The transformation of organic and inorganic compounds in the soil has long been considered the particular function of soil bacteria, but molds may also play an important rôle in such processes, and indeed it is conceivable that in some instances they may prove largely responsible for the simplification of complex soil materials.

It is not the purpose of this paper to review the previous studies on molds, for excellent bibliographies have been presented in the work of Waksman[4] and Coleman[2] already referred to. It is desired merely to call attention in a brief way to the varied action of molds in soils, and to present a compilation of various published data and some of our own unpublished results along this line, with the idea of emphasizing the need of further study of these organisms.

In the first place, the number of molds in soils should be considered, and while data along this line are far from conclusive, it has been shown that large numbers of these organisms are always present. Especially is this true for soils rich in humus, and acid in reaction. But the occurrence of fungi is not restricted to such abnormal soils. Neutral, well-aerated and well-fertilized soils are also found to contain rich mold floras. Furthermore, fungi are not limited merely to the surface soil, but occur in the deeper soil layers. The well-known predilection of certain fungi for acid conditions has been confirmed and leads to interesting conclusions regarding the special importance of these forms in acid soils in which beneficial bacterial action is largely restricted.

A very important point in connection with the occurrence of molds in soils has been studied recently by Waksman.[5] While the counting methods employed have shown the large numbers of molds in soils, considerable doubt existed as to whether these counts represented the actual number of active fungi or only the spores. If spores alone are present, the activity of molds in soils may be of less immediate importance although their presence would indicate previous active growth as well as future activity when the soil conditions become satisfactory for the development of active forms from the spores. Active mold growth on the other hand would undoubtedly be of immediate importance in the chemical changes occurring in the soil. The value of definite information along this line is apparent. The careful experiments of Waksman show that many molds occur in soils in an active state as well as in the form of spores. While certain groups do not appear to be present in an active condition in the soils tested, although the plate method showed their occurrence as spores, studies of other soils may lead to different conclusions.

Conn[3] has attempted to check Waksman's results by the use of smaller quantities of soil, but was unsuccessful. Using 10 mg. of soil, he secured no growth of mold mycelia such as Waksman obtained with lumps of soil 1 cm. in diameter. He describes a direct microscopic examination of soils and finds no mold mycelia present. He concludes from these experiments that there is serious doubt whether molds exist in soils in an active form *in sufficient num-*

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[2] Coleman, D. A., “Environmental Factors Influencing the Activity of Soil Fungi,” *Soil Science*, Vol. II., No. 1, p. 1.

[3] Conn, H. J., “Relative Importance of Fungi and Bacteria in Soil,” SCIENCE, N. S., 44, p. 857.

[4] Waksman, S. A., “Soil Fungi and Their Activities,” *Soil Science*, Vol. II., No. 2, p. 103.

[5] Waksman, S. A., “Do Fungi Actually Live in the Soil and Produce Mycelium?” SCIENCE, N. S., 44, p. 320.

bers to be important compared with bacteria. There seem to be two questions involved here: How large a proportion of the number of molds developing on plates represent active forms and how many spores? What is the number of active mold forms which need be present in the soil for them to be considered important in the various soil chemical processes?

The first of these questions is rather difficult to answer at the present time, but our experiments indicate that rather a large proportion of the total number of molds present in various soils occur in the active state. We have found active mold growth occurring in all the soils thus far examined, and we have used both Waksman's and Conn's methods. Our results confirm Waksman's observations, therefore, and Conn's criticism seems unwarranted, for *active mold mycelia have developed in all our tests, using not only 10 mgs. but also smaller quantities of soils, as well as* the larger lumps employed by Waksman. The soils tested are normal soils, many of them untreated and none extremely rich in humus.

Further work along this line is certainly desirable, but from our observations thus far there seems no doubt but that *fungi occur actively in soils,* and hence we feel that their action must be important regardless of their relative numbers compared with bacteria. Furthermore the presence of spores is likewise important for they may become active in the near future and bring about their characteristic reactions. The answer to the second question mentioned above can only come after long-continued experiments, but from the vigorous action of molds noted in so many cases, as will be pointed out later, it is evident that the problem of microorganic activity in relation to soil fertility can not be completely solved without a knowledge of mold growth. Perhaps they are not as important as bacteria, there is no means yet of knowing, but even if of secondary significance they deserve recognition. Our present knowledge of soil fertility is too incomplete to permit us to pass over hastily any possibly important factors without thorough study.

We believe, therefore, that molds occur in most soils, both in the active and in the spore state, and hence they must pass through their various life cycles in the soil. Furthermore, different soils undoubtedly have different fungus floras. Species present under one combination of conditions may be absent under others. Organisms present only as spores in one case may occur actively in other instances. Finally, it seems perfectly possible that the relative occurrence of active and spore forms of various organisms may vary in the *same* soil with varying conditions of moisture, temperature, aeration, reaction and food supply.

Considering the occurrence of molds in an active state in all soils an established fact, the importance of these organisms in the decomposition of the soil organic matter becomes evident. Many experiments have been conducted along this line and it has been very clearly demonstrated that molds are very efficient ammonifiers. Indications have been secured that there exists a correlation between the biological stage of the organisms and the periods of ammonia accumulation. The largest amount seems to accompany the periods of spore germination and the smallest amount the time preparatory to actual spore formation.

All the nitrogenous organic materials which make up the humus content of soils are easily attacked by various fungus forms and ammonia is liberated in large amounts. Part of this ammonia may, of course, be utilized by them, but by far the larger part is set free and may be subsequently nitrified for use by the higher plants. Various fertilizing materials containing complex nitrogenous compounds may be ammonified by soil fungi, and their decomposition considerably facilitated. For instance, experiments with cyanamide show its rapid transformation to ammonia by certain molds. Ammonia production from urea by molds has also been definitely proven.

The non-nitrogenous portion of the soil organic matter is also attacked by many molds. Thus experiments have shown that cellulose is rapidly decomposed by many species, and other substances such as sugars, pectins, oils, fats, waxes, organic acids, etc., are likewise broken down by molds. Some recent results secured in our laboratories show the large carbon-dioxide production by molds. No doubt, therefore, remains but that these organisms play an extremely important part in the decomposition of all soil organic matter and indeed certain results indicate that their action along this line may be much greater than that of bacteria, at least under certain soil conditions.

No experiments have yet been reported which indicate that molds may bring about nitrification, and this process, therefore, still appears to be purely bacteriological. Further experiments may modify this conclusion.

Denitrification and deazotofication, however, processes now known to be of slight significance in normal soils, but which may occur in highly manured, specially treated greenhouse and market garden soils, may possibly be brought about by the action of molds. The introduction of these organisms with the manure used may be an important factor here. Definite data along this line are lacking at the present time.

Non-symbiotic nitrogen fixation, or azofication by molds has been studied from time to time and indications have been secured that certain species may be able to utilize the nitrogen of the atmosphere. The results, as a whole, however, are far from satisfactory and indeed the conclusion has been drawn that at the present time the "weight of the conclusions on the fixation of nitrogen by fungi seems to be on the negative side." Further experiments along this line are certainly desirable.

The utilization of various nitrogen compounds by molds has been studied to some extent, and it has been found that ammonia and nitrate compounds are assimilated by these organisms in considerable amounts. Thus under extreme conditions of mold growth it is conceivable that molds may be actual competitors with the higher plants for nitrogenous food materials. It is not believed, however, that such conditions would occur except very rarely. A knowledge of mold growth in soils may be of some significance, nevertheless, in connection with the questions involved in the fertilization of soils with nitrates and ammonium salts.

The decomposition of mineral compounds in soils by molds has been studied only to a very slight extent. Data secured in our laboratories very largely in connection with certain chemical and bacteriological studies indicate, however, that these organisms may play an extremely important rôle, not only in preparing nitrogenous food materials for plants as has been indicated, but also in making other mineral constituents available. Complete data along the various lines indicated will be published later.

Studies of the production of available phosphorus by bacteria and molds have shown the vigorous action of various fungi in this direction. Several experiments carried out by various methods have shown that rock phosphate is apparently transformed much more rapidly into a soluble form by many molds than by bacteria. The importance of further study along this line in connection with the solution of the moot question regarding the relative merits of rock phosphate and acid phosphate can readily be seen.

The oxidation of sulfur in the soil, or sulfofication, a process which has recently received some attention and which gives evidence of being of great importance from the soil fertility standpoint has been shown to be accomplished by several species of molds. The action of these organisms in this process may become of special importance in connection with the recent suggestion for the production of available phosphorus by composting rock phosphate, sulfur and soil or manure.

The process of ferrification, or iron oxidation in soils, while largely chemical in nature according to results thus far secured, is brought about partly by microorganisms and certain molds are apparently much more active in this action than any of the bacteria studied.

Experiments on the production of available potassium by molds should also yield interesting results. No data have yet been secured on this point.

In fact, it seems evident that mold action in soils may be of far greater significance than has previously been supposed in preparing available food for plant growth. No longer should the study of microorganic activities in soils consider bacteria alone. Mold action must also be investigated, and in most cases it is undoubtedly true that only vague, incomplete results can be secured if such mold studies are not included. Many results secured in bacteriological investigations might be explained and interpreted much more clearly and definitely if the activities of molds were considered.

If soil bacteriology is to be developed to the proper extent in the future and the relation of microorganisms to soil fertility is to be established with any degree of certainty, investigations must include not only bacterial action, but the activities of molds and possibly also the growth of protozoa and algæ.

It is certainly desirable that the investigations of molds in soils and their activities and importance be carried out much more generally and on a larger scale than is the case at present. Here is a field of study rich in possibilities and the importance of work along these lines can not be questioned.

P. E. BROWN

IOWA AGRICULTURAL EXPERIMENT STATION

THE U. S. BIOLOGICAL STATION AT BEAUFORT, N. C., DURING 1916

THE general appearance of the site of the station was materially enhanced during the year by enlarging the improved portion of the grounds, and by planting grass, sea oats, trees, and shrubbery. Through these improvements the comfortableness of the station was also increased. The laboratory, as usual, was open during the summer to special investigators. The investigators, with a single exception, had engaged in research at this station before and they continued during the past season lines of work previously undertaken.

The present large series of experiments in diamond-black terrapin culture, which was started in 1909, has progressed with marked success. Several new experiments in addition to those already under way were undertaken. There are now approximately 1,600 terrapins, exclusive of the young of 1916, in the pounds which are being used for experimental purposes. This experimental work has shown quite conclusively that terrapins can be grown and kept in vigorous condition in captivity, for some of the earliest broods, hatched in the pounds at the station, have reached maturity and are very prolific in the production of eggs, and the offspring is equally as vigorous as that of the wild terrapins confined after maturity had been attained.

A total of 2,611 terrapins hatched during the summer of 1916 has to date been taken from the egg beds. This number will be somewhat increased in the spring when terrapins appear that were overlooked in the fall. Among these young removed from the egg beds there are 666 which are offspring of terrapins reared in captivity. The total number of young produced during the previous year, including those found in the spring, was 2,128; of these 50 were offspring of terrapins grown in captivity. It has been known for some time that a female terrapin may lay twice during a single season, but during the past season through the discovery of 12 nests, averaging 8 eggs to a nest, in a pen where only four females are confined, it is evident that a female may lay as often as three times during a single season.

The most gratifying results of the past year are the unusually rapid growth of the young of one year and less of age and the very low mortality. The death rate among the 1915 brood during the first year was about 8 per cent., while formerly it occasionally ran as high as 40 per cent. The death rate among the young after the age of one year or more is attained is negligible.

The observations on the habits of fishes was continued by the director of the station. It is very noteworthy that food fishes generally were unusually scarce in the Beaufort region during the past year. The "gray trout" (*Cynoscion regalis*) which is normally, with perhaps a single exception, the most important food fish of the locality, was so scarce that the fishery was almost wholly abandoned. The almost total failure of a "run" of the two important fall species, the spot (*Leiostomus xanthurus*) and the jumping mullet (*Mugil cephalus*), is equally as noteworthy.

The pig fish (*Orthopristis chrysopterus*) was found in spawning condition on the inner shore of Shackelford Banks during May and the early part of June, but the eggs of this species seem to be difficult to hatch artificially. Spawn taken in the field by stripping was brought to the laboratory for hatching, but these efforts failed. Then ripe or nearly ripe fish were confined in live cars and tanks. Those in the live cars were stripped when apparently very ripe, and those in the tanks were allowed to spawn naturally. At no time was fertilization obtained in eggs artificially spawned, but of those spawned naturally, a small percentage was successfully fertilized and cell division ensued, but all died before hatching. These experiments having failed, the eggs, which are semibuoyant in sea water, were taken by means of a tow-net and brought to the laboratory. These too died before hatching. The methods of hatching employed were those which are usually successful with other species.

The study of the life history of *Gambusia* was continued chiefly for the purpose of verifying observations of previous seasons. In connection with the study of fishes in relation to the mosquito problem, it was found that the common eel (*Anguilla rostrata*) may, at least under more or less abnormal conditions, be of value as an eradicator of mosquito larvæ, for small specimens taken from reservoirs receiving the overflow of an artesian well were found to have subsisted chiefly on mosquito larvæ, which in this instance constituted about the only food available. These eels were not confined in these reservoirs, but had come there through choice by passing from salt water through the overflow from the reservoirs, a passage which remained open for an exit as well as an entrance. This then indicates that the common eel should not be overlooked in the study of fishes in relation to the destruction of the mosquito. Several collecting trips to fresh-water ponds and streams in the vicinity of the laboratory yielded the following species of fishes which do not seem to have been recorded from this immediate vicinity; *Ameiurus erebennus* Jordan, *Ameiurus catus* (Linnæus), *Erimyzon sucetta* (Lacépède), *Notemigonus crysoleucas* (Mitchill), *Notropis procne* (Cope), *Dorosoma cepedianum* (LeSueur), *Esox americanus* Gmelin, *Esox reticulatus* LeSueur, *Aphredoderus sayanus* (Gilliams), *Centrarchus macropterus* (Lacépède), *Chænobryttus gulosus* (Cuvier & Valenciennes), *Enneacanthus gloriosus* (Holbrook), *Lepomis gibbosus* (Linnæus), *Lepomis incisor* (Cuvier & Valenciennes), *Micropterus salmoides* (Lacépède), *Perca flavescens*

(Mitchill), *Boleosoma olmstedi* (Storer), *Copelandellus quiescens* (Jordan). The two marine species, *Synodus intermedius* (Agassiz) and *Myrophis punctatus* Lütken, appear to be new to the Beaufort fauna.

Dr. Albert Kuntz, of the St. Louis University School of Medicine, continued the study of the embryological and larval development of fishes carried on during several seasons. Experiments in rearing larvæ gave only negative results.

Dr. Kuntz also made a detailed study of the skin of flounders adapted to backgrounds of different colors for the purpose of determining the degree of distribution of melanin and xanthine pigment and the relationship of the guanophores with the chromatophores when a given shade or color is assimilated as nearly as possible. Shade was found to depend primarily on the degree of distribution of the melanin pigment and the relationship of the guanophores with the melanophore. Color depends on a complex group of factors including the relative degree of distribution of melanin and xanthine pigment and the optical effects due to the diffraction of light by the guanin crystals in the guanophores.

Mr. Arthur Jacot, of Cornell University, continued for the second season the study of the life history of the mullets of the Beaufort region. It was definitely determined that the nominal genus *Querimana* comprises the young of the genus *Mugil*. At a certain period in their lives the young mullets pass through a gradual change which gives them the full adult characters. During this time the first soft ray of the anal fin is transformed into a spine, a change in the sculpture of the scales giving the appearance of a winter line also takes place, and the color is changed more nearly to that of the adult. The "jumping mullet" (*Mugil cephalus*) spawns in the fall, from October to December. The young grow rapidly and attain a length of 5 or 6 inches when one year of age. Then they appear to migrate southward by a slow and leisurely movement. In the spring they migrate northward, but by a more direct and apparently more continuous run. This migration causes a cessation of feeding and therefore of growth which is so marked as to affect the scale, leaving a "migration line." The jumping mullet, as shown from these studies, normally attains maturity when two years of age, but it may continue to grow until at least five years old. The "silverside mullet" (*Mugil curema*) spawns in the spring and the young grow rapidly. In the fall they leave the harbor to return only in small numbers. A careful search was made for the eggs and larvæ within the harbor and along the outer shores of Shackelford and Bogue banks, but no eggs or young less than 20 mm. in length were found. Since the eggs and larvæ of the jumping mullet too have not been found by the use of similar methods in the same locality, it is inferred that these two species are pelagic in their spawning grounds.

Mr. O. W. Hyman, of the University of Tennessee, continued his experiments and observations on the larval development of crustaceans. The experiments in rearing zoeæ were unsuccessful, but the observational work yielded better results. The first zoea stages of *Minippe* and *Callinectes* were secured, but could not be reared beyond this stage. Scattered observations were made on the life history and habits of *Minippe*. The megalops of *Callinectes* were taken in abundance and it was found that they were hardly in confinement and molted readily to the crab stage. The young crabs molted and grew rapidly. The entire life history of the common sand-fiddler (*Uca pugilator*) was worked out. Camera lucida drawings were prepared of each stage and of all appendages of each stage.

Dr. James J. Wolfe, of Trinity College, Durham, N. C., continued his investigation of the diatom flora of the Beaufort region. This work has been greatly hampered by the difficulty encountered in securing the very scattered literature on the subject. It is proposed in the present work to give carefully revised citations and descriptions of every form occurring in the vicinity. It is also proposed to offer carefully prepared illustrations of the commoner forms.

In addition to the above Dr. Wolfe, assisted by Mr. Bert Cunningham, of the Durham, N. C., city schools, began an investigation of the plankton collections made by the U. S. Fisheries steamer *Fish Hawk* in the Chesapeake Bay region. Some thirty-odd collections were examined by the employment of methods which it is believed will furnish fairly accurate data concerning the numerical relations of all the important species as they vary according to depth, season and locality.

Dr. L. F. Shackell, of the University of Utah, continued his studies on the toxicities of various constituents of coal-tar creosote for the marine wood borer, *Limnoria*. Among the preparations tested were composite samples of tar bases of different boiling points, obtained through the courtesy of Mr. S. R. Church, of the Barrett Manufacturing Company. It was found that the bases were highly toxic for *Limnoria;* and that the toxicity increased with the rise of the boiling point—paralleling in this respect the results previously obtained for the tar acids.

Professor H. V. Wilson, of the University of North Carolina, spent a short time at the laboratory, continuing the study and identification of the "Albatross-Philippine Sponge Collection." Since but little work had previously been done on the sponges of the far east, it is not surprising that many of the forms proved to be undescribed.

Mrs. E. Bennet Decker, of Washington, D. C., again served as station artist. She prepared a number of illustrations of diatoms for Dr. Wolfe and made drawings and sketches for Dr. Kuntz and for the director.

SAMUEL F. HILDEBRAND,
Director

BUREAU OF FISHERIES,
WASHINGTON, D. C.

PHILIPPE DE VILMORIN

WITH the death of Philippe Levêque de Vilmorin on June 30, genetics and horticulture lost a remarkable friend. His published work in both fields is valuable, but perhaps surpassed by his personal influence, which he owed largely to his position as head of the large and wealthy de Vilmorin family, and of the firm of Vilmorin, Andrieux & Co., of Paris, one of the most celebrated seed-growing and seed-selling establishments in the world.

The firm first appears in 1727 as a little seed store "*Aucoque de la bonne foy*" on the bank of the Seine, kept by one Pierre Geoffroy, whose daughter and heiress married the botanist Pierre d'Andrieux. A young botanist from Lorraine, Philippe-Victoire Levêque de Vilmorin, formed an intimacy with Andrieux, and in 1774 married his only daughter. Since then the firm has borne the name of the two families, although controlled wholly by the de Vilmorins. It has been handed on from father to son, and many of the family have contributed to agricultural science. The best known is Louis de Vilmorin (1816–1860), whose name is always connected with the sugar beet.

Of the early French contributors to genetics some, like Victor Lemoine, are known only as practical hybridizers; others have done purely theoretical work, as Jordan with his study of the nature of species, and Naudin with his observations on the segregation of characters in hybrids. Louis de Vilmorin is conspicuous in both classes. To theory he contributed the centgener method of breeding; to practical agriculture he contributed the sugar beet, whose saccharine content he raised from 10 per cent. to 18 per cent. by a carefully planned series of selections. Little improvement has been made in this beet since it left his farm.

He was succeeded by his son Henri, as head of the business and the family, and Philippe, who has just died, succeeded Henri in 1899. Philippe turned over the active management of the family business to his brother-in law, Comte d'Etienne, and gave the greater part of his own time to scientific research.

In horticulture he published studies of the beet-sugar industry of the United States, the culture of ginseng in Korea and Manchuria, and the tobaccos of commerce. He likewise edited three important publications of the firm: *Les Fleurs de Pleine Terre, Le Manuel de Floriculture,* and the *Hortus Vilmorinianus.*

The most important of his published work in genetics deals with wheat, but he also carried on a long series of dog-breeding experiments and, through the firm, made possible the researches of Hagedoorn, Meunissier, Mottet and other geneticists. He was largely responsible for the Fourth International Conference on Genetics, held in Paris in 1911. As secretary, he did most of the work connected with it; as financial guarantor, he furnished most of the funds needed for it. The large volume of *Proceedings*, which he edited and published at his own expense, is a fitting memorial to his zeal in the promotion of scientific research.

PAUL POPENOE

WASHINGTON, D. C.

SCIENTIFIC EVENTS

THE PRODUCTION OF IRON ORE AND PIG IRON IN 1916

THE iron ore mined in the United States in 1916 reached a total of 75,167,672 gross tons, the greatest annual output ever made. The shipments from the mines in 1916 were 77,870,553 gross tons, valued at $181,902,277. The quantity mined in 1916 was more than 19,600,000 tons greater than that mined in 1915. The increases in quantity and in value of iron ore shipped in 1916 amounted to about 40 and 80 per cent., respectively. The average value per ton at the mines in 1916 was $2.34, as against $1.83 in 1915. These figures, which were compiled under the direction of E. F. Burchard, of the United States Geological Survey, Department of the Interior, include for 1916 only iron ore containing less than 5 per cent. of manganese.

Iron ore was mined in 24 states in 1916 and 23 in 1915. Minnesota, Michigan and Alabama, which have for many years produced the largest quantities of iron ore, occupied in 1916 their accustomed places.

The Lake Superior district mined nearly 85 per cent. of the total ore in 1916 and the Birmingham district about 8 per cent. No other district except the Adirondack mined as much as 1,000,000 tons. The increase in production in 1916 was especially marked in the Adirondack and Chattanooga districts—54 and 55 per cent. respectively—but every district showed an increased output over that of 1915.

All the ranges in the Lake Superior district mined a larger quantity of iron ore in 1916 than in 1915, and the largest increases were in the Gogebic and Menominee ranges—54 and 43 per cent., respectively. The output of the Cuyuna range exceeded 1,500,000 tons for the first time.

There were 12 mines in the United States that produced more than 1,000,000 tons of iron ore each in 1916, five more than in 1915. First place in 1916 was held by the Hull-Rust mine, at Hibbing, Minn.; second place by the Red Mountain group, near Bessemer, Ala.; third place by the Fayal mine, at Eveleth, Minn., and fourth place by the Mahoning mine, at Hibbing, Minn. The production of these mines in 1916 was, respectively, 7,658,201, 2,899,588, 2,252,008 and 2,215,788 tons. The increase at the Hull-Rust was 232 per cent., making the production of this one mine more than one tenth of all the ore mined in the United States in 1916. These records illustrate the rapidity with which the rate of output of mines in the Lake Superior district may be increased. None but open-pit mines could be made to respond to demand to such a degree.

The production of pig iron, including ferro-alloys, was 39,434,797 gross tons in 1916, compared with 29,916,213 gross tons in 1915, an increase of 32 per cent., according to figures published by the American Iron and Steel Institute, February 24, 1917. The pig iron, exclusive of ferro-alloys, sold or used in 1915, according to reports of producers to the United States Geological Survey, amounted to 39,126,324 gross tons, valued at $663,478,118, compared with 30,384,486 gross tons, valued at $401,409,604 in 1915, a gain of 29 per cent. in quantity and 65 per cent. in value. The average price per ton at furnaces in 1916 as reported to the Survey was $16.96, compared with $13.21 in 1915, an increase of 28 per cent.

RESEARCH IN AERONAUTICS

THE report of the British Advisory Committee for Aeronautics for 1916–17 is summarized in the Engineering Supplement of the London *Times.*

It is said that owing to the numerous changes and development in the design and construction of aircraft an increasing number of special problems constantly presented themselves for investigation, and these have closely occupied the attention of the staffs engaged in experimental work at both the National Physical Laboratory and the Royal Aircraft Factory. In addition to aerodynamical research, much attention has been given to questions relating to engines, materials of construction, strength of construction and design, instruments and accessories, as well as to methods of attack of aircraft from aircraft and other matters.

In the new 7 ft. air channel at the National Physical Laboratory an air speed of 85 ft. per second can be reached with an expenditure of 160 h.p. It is doubtful whether further increase in size of channel or speed of air current would advance existing knowledge to an extent sufficient to outweigh the greatly increased cost and other disadvantages involved. Should it prove necessary to conduct experiments on a larger scale and at higher speeds, it would appear necessary to employ a method in which the model is moved through the air. This procedure presents various difficulties, and the securing of even moderately accurate data in this manner is at the best extremely laborious. Probably the least troublesome way of applying this method is by installing measuring apparatus on the aeroplane itself, and it seems probable that only in this way can an accurate comparison be obtained between model and full-scale conditions.

Improved methods of supporting the models under test have been devised for use in special cases. The effect on the measured resistance of the method of holding the model is often surprisingly large, and without the necessary care and experience in avoiding effects due to interference with the air flow very large errors may result. In general the difficulty is greatest in measurements on forms of small head resistance—*e. g.*, aeroplane bodies and airship envelopes. Probably little reliance can be placed on the absolute values obtained in earlier measurements on airship models of stream line shape, which were made to determine the form of least resistance, and were in the main comparative. With the new methods of support the possible error has been greatly reduced, and when full-scale values have been determined with accuracy the prediction of full-scale resistance from the models will be established on a satisfactory basis.

At the Royal Aircraft Factory the measurement of the resistance of aeroplanes in flight has been continued with the object of confirming the model experiments, and an instrument for measuring the resistance directly has been developed. The distribution of pressure over the wing of an aeroplane in flight has been measured, and further experiments on these lines are in progress. Experiments and also much theoretical work have been carried out on the longitudinal and lateral stability of aeroplanes in flight. Measurements have also been made of the disturbance of the air behind a propeller, to obtain data required in the design of new machines.

SCIENTIFIC NOTES AND NEWS

President Raymond A. Pearson, of the Iowa State College, and Clarence Ousley, of the Texas State College, have been appointed to be assistant secretaries of agriculture.

Dr. Ray L. Wilbur, president of Stanford University and formerly professor of medicine, has been placed in charge of the conservation department of the Food Administration.

The Women's Council of Defense announces the following advisory committees: *Food Utilization.*—Professor R. H. Chittenden, Professor Graham Lusk, Professor E. V. McCollum, Professor L. B. Mendel, Dr. C. L. Alsburg, Dr. C. F. Langworthy, Professor Vernon Kollogg, Dr. A. E. Taylor and President Ray L. Wilbur. *Public Health.*—Professor W. H. Welch, chairman, Dr. L. P. Ayer, Dr. Hermann M. Biggs, Dr. D. L. Edsall, Dr. Cary T. Grayson, Dr. A. W. Hewlett, Dr. A. C. Janeway, Dr. F. G. Novy, Dr. R. M. Pearce and Professor H. G. Wells.

Dr. Harriet L. Hartley has been appointed chief of the division of child hygiene, of the Philadelphia department of health, succeeding the late Dr. Henry H. Doan.

Dr. J. B. Cleland, of the Sydney department of public health, has been elected president of the Royal Society of New South Wales.

Mr. Alan A. Campbell Swinton has been elected chairman of the council of the Royal Society of Arts, London.

We learn from *Nature* that early in July Mr. Erik Andersson, of Uppsala, again led to Spitsbergen a geological expedition, which included Messrs. Adam Reuterskiöld, Sven Ydén and Karl Samuelsson. The main object was to continue the investigation of the Trias and to collect saurians and fishes. The occurrence of phosphorite at Cape Thordsen was to be investigated, as well as the extent of the coal beds at Pyramid Hill and Bunsowland. Investigations in the Devonian rocks are to be continued and their vertebrate fossils collected. A large expedition of miners and mining engineers also left Sweden about midsummer to exploit the coal measures of Spitsbergen, and was accompanied by Dr. Anteus as geologist.

The Committee of the Privy Council for Scientific and Industrial Research has sanctioned the appointment of a committee to inquire into the types of breathing apparatus used in coal mines, and by experiment to determine the advantages, limitations and defects of the several types of apparatus, what improvements in them are possible, whether it is advisable that the types used in mines should be standardized, and to collect evidence bearing on these points. The members of the committee are: Mr. W. Walker, acting chief inspector of mines under the Home Office (chairman), Dr. J. S. Haldane and Dr. H. Briggs.

Dr. G. Carl Huber, professor of anatomy in the University of Michigan, recently delivered an address on "Early Stages in Mammalian Development" before the faculty and students of the graduate summer quarter in medicine of the University of Illinois.

Two courses of twelve lectures each on "The Designing and Computing of Telescope Systems" are being delivered at the Imperial College of Science, South Kensington, by Professor A. E. Conrady during this month and September. The lectures are given in connection with the newly formed department of technical optics under the direction of Professor F. J. Cheshire.

The death is announced of M. Eduard Sarasin, of Geneva, editor of the *Archives des sciences physiques et naturelles*, and the author of numerous researches in physicial science.

By an agreement between the executors of the estate of the late James Buchanan Brady and his heirs, the major part of his fortune, estimated at $3,000,000, becomes immediately available for the New York Hospital. This argeement enables the trustees and executors to carry out the testator's plans for the establishment of the James Buchanan Brady Foundation of Urology. Eventually a building will be erected for the foundation to cost about half a million dollars, which will include departments for investigation along chemical, bacteriological and pathological lines. The plans for the foundation are in the hands of Dr. Oswald S. Lowsley, who was named by Mr. Brady as director.

At the annual general meeting of the Medico-Legal Society of London, when the President, Sir Samuel Evans, was in the chair, a recommendation of the council that aliens of enemy nationality should cease to be either honorary or ordinary members of the society, was unanimously approved.

The British Museums Association proposes to hold a conference in October to discuss, among other subjects, local war museums and the Board of Education and museums.

Plans for the one hundred and fifteenth meeting of the American Institute of Mining Engineers which include an inspection of the coal resources of Illinois, the zinc and other mining operations of Missouri, and the oil fields of Oklahoma have been announced. The meeting will be held during the week of October 8 to 13. Methods will be discussed for conserving the present supply and increasing the output of the country's minerals which will prove of value in winning the war. The American Institute of Mining Engineers now numbers more than 6,000 members in every part of the country and in many parts of the world and representatives will be present of all the principal American mining centers. The program calls for several days' sessions in and around St. Louis and an inspection tour to the rich mineral Joplin-Miami district and the oil fields of Tulsa, Oklahoma. The engineers will be guests of the St. Louis section of the institute, the chairmen of committees including H. A. Buehler, state geologist of Missouri; F. W. De Wolf, Illinois, past president of the Association of State Geologists; James E. Caselton, St. Louis; A. H. Wheeler, St. Louis; E. F. Goltra, St. Louis. Philip N. Moore, of St. Louis, is president of the American Institute of Mining Engineers.

The Société de Chimie Industrielle has been founded in Paris to promote the science of chemistry as applied to industry. We learn from a statement in *Nature* that local provincial branches will be formed which, while being self-governing, will keep in touch with the parent society. The society will institute research work with the view of assisting manufacturers and agriculturists. An institute and library are in contemplation which will contain a complete collection of French and foreign periodicals devoted to industrial chemistry, and the society hopes to arrange for meetings, exhibitions, etc., to stimulate activity. A review—the first number of which is expected to be published shortly—will keep manufacturers posted in the latest developments at home and abroad, describe inventions and processes, and, generally, fill a want that has been long felt in France. The first council of the society contains many names prominent in the scientific and industrial world.

The War Council of the American Red Cross has established a Bureau of Sanitary Service under the direction of Dr. W. H. Frost. An appropriation of $600,000 has been made for the use of the bureau. This step has been taken in order to meet the new conditions which will arise as a consequence of bringing together so many men as will be mobilized throughout the country. The Bureau of Sanitary Service will supervise and aid in such operations as will tend to make health conditions about the camps as nearly ideal as possible. Increased forces will be provided for milk inspection, war will be made on malaria-carrying mosquitoes, and a radius of from fifteen to sixty square miles outside of the camps will be policed for the protection of the health of the men. Sanitary units will be furnished to the areas upon the request of the civil authorities.

The council of the British Medical Association has reported that the only possible method of placing the health administration of the country on a sound basis was by the creation of a Ministry of Health. Their recommendations are as follows:

> That a ministry of health should be created to take over from existing government departments such duties as are concerned with the health of the community, and to deal with those duties only; that the administrative functions of the ministry should be carried out by a board presided over by a minister of Cabinet rank, that the country be divided into suitable administrative areas under local administrative health centers consisting of representatives (*a*) of the rating authorities; (*b*) of the education authorities; (*c*) of the persons contributing to a scheme of health insurance (including employers of labor); (*d*) the medical profession; (*e*) public hospitals; (*f*) dentists; (*g*) pharmacists, and (*h*) nurses; that the principal medical officers of each center should be two, of equal status, one representing the clinical side (chief clinical officer) and the other the preventive side of medicine (medical officer of health); that for each area, hospitals, clinics, or treatment centers should be recognized or established at which persons entitled to treatment under the public scheme should be able to obtain institutional, consultative or specialist services on the recommendation of their medical attendant.

UNIVERSITY AND EDUCATIONAL NEWS

For the Oklahoma College and Station a science building to cost $100,000 was authorized by the last legislature.

By the will of the late Sir Charles Holcroft a bequest of £5,000 is made to the University of Birmingham, to establish a Charles Holcroft Research Fund.

Funds for the new chemical laboratories at University College, London, have been raised by a committee, of which Prince Arthur of Connaught is president and Captain the Hon. Rupert Guinness chairman and treasurer. The cost of the site, building and equipment will be £120,000. £100,000 has already been raised, leaving £20,000 to be found. In order to facilitate the immediate provision of this, Sir Ralph C. Forster, who has already subscribed generously to the cost of the laboratories, has promised £5,000 on condition that the remaining £15,000 is raised speedily.

A School of Mines has been organized at Washington State College at Pullman. Under the new plan, the department of mining becomes one of the eight schools or colleges that comprise this state institution, and Professor Francis A. Thompson, head of the department, becomes dean of the School of Mines. Full facilities will be available for instruction in, and treating ores by, all standard forms of treatment, including leaching, amalgamation, concentration, roasting and smelting. A special laboratory will be devoted to the flotation process.

A. B. McDaniel, former assistant professor of civil engineering, University of Illinois, has been given administrative charge of the general engineering department of Union College, Schenectady, N. Y.

H. B. Ellenberger, Ph.D. (Cornell), has been appointed associate professor of animal and dairy husbandry at the College of Agriculture of the University of Vermont.

Professor Henri Roger has been appointed dean of the school of medicine of the University of Paris, to succeed the late Professor Landouzy.

DISCUSSION AND CORRESPONDENCE

TEACHING CHEMISTRY AND TEACHING CHEMISTS

Looking over the lists of chemistry courses offered in the various colleges and universities, one is impressed by the thoroughness with which the field has been covered. To suggest additions to the already long lists may seem, at first thought, uncalled for. There is a group of courses so obviously essential that we find them taught in every university, and there is a pretty clear understanding of what courses belong to this group. Supplementing this basic group are numerous courses extending and amplifying it in various directions determined by local influences, traditions and training of the staff members. The scheme has one serious defect, which is that there is seldom to be found in the whole list of courses, a single one designed to give the would-be chemist an intelligent and comprehensive idea of the science of chemistry, its history, literature, and rôle in a modern civilized world. A man who diligently pursues the courses offered will undoubtedly attain to a considerable knowledge of the laws, facts and theories of chemistry. Will he then be a chemist?

The writer was recently called upon to grade the examination papers of contestants for the Alpha Chi Sigma Scholarship Medal. There were eighteen contestants, representing ten prominent universities or colleges. Contestants were all in the second semester of the junior year and, since they undertook to compete in a scholarship examination, may be considered as somewhat more alert than their classmates. That grades attained would differ widely was to be expected. The sequence of courses is not the same in the schools represented, and various other factors contribute to make it difficult to get an adequate measure of the relative standing of students; but, allowing for all these, there was clearly shown a striking lack of information and of view point whenever the questions of the examination passed beyond the field of strictly chemical facts, laws and theories. A few examples will illustrate the point: Of the eighteen contestants, eight were unable to name a single American journal of chemistry, eleven were unable to name an English journal, thirteen could not name a French journal, and eight could not name a German journal. Of the eighteen contestants, only five could name a general treatise on inorganic chemistry; only nine could name such a work on organic chemistry. Twelve of the eighteen could not name the president of the American Chemical Society. Only six of them knew of the recent work on the atomic weight of lead; only two of the eighteen could name three important chemical discoveries of the last ten years. Bunsen, Scheele, Wöhler, Ramsay, Mendeljeff were, to most of the contestants, just names of chemists who had done something or other. Required to name five prominent living chemists, most of them named three or four of the members of the local chemistry staff. Some of the men named are, indeed, prominent chemists, but when a student indicates that four out of five of the world's prominent chemists are included amongst his instructors, he is showing a lack of viewpoint rather than an intelligent loyalty.

It is far from the purpose of this note to belittle the knowledge of these students. They are, in all probability, more intelligent than the average. The point is that they should have, after three years of study in the field of chemistry, some knowledge of the use of a chemistry library, and more than a naïve understanding of contemporary chemistry. Perhaps we have expected them to absorb general chemical information from the atmosphere of a chemistry department. The actual situation is that their views of chemistry are hedged in between the covers of some ten or twenty text-books. If this is the case, would it not be worth while to add to our chemistry curricula a few courses—call them what you will—aimed squarely at supplying that body of general chemical information not to be found in text-books? To teach chemistry is one thing; to teach men to be chemists is a greater task.

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ANOTHER PHASE OF "ACADEMIC FREEDOM"

DURING the last few years there has been considerable agitation and many articles have been written upon the danger of loss of "academic freedom," by which is meant the right of college and university teachers to think and express their thoughts without fear of losing their positions through the possible unpopularity of their own opinions. All who are associated in any way with education realize the danger of political and financial overshadowing of independent thought, especially when it is opposed to the established order of things. It is evident, however, that there are still some who do not grasp the essential difference between the clerical attitude toward education a hundred years ago and the scientific attitude toward education to-day. A hundred or more years ago the imparting of information and of established creed was believed to be the entire function of the institutions of learning. To-day we advocate the stimulation of active, progressive thought which questions established ideas and is anxious to have before the mind all possible theories in order to further stimulate thought and investigation. A recent incident shows, however, that such is not by any means the attitude of all who should be leaders in freedom of expression of thought, but who are not.

In the December twenty-ninth issue of SCIENCE of last year a short item entitled "*1916 or 1816?*" calls attention to the fact that a certain literary society in one of our universities was announcing a phrenological lecture with the title "Brains—How to Know and Handle Them." The author of the note says simply at the end of his quotation of the announcement: "Comments would seem superfluous." However, it seems that they were not to him "superfluous," since in the January nineteenth issue of the same journal, under the caption "Phrenology," the same writer says, "It is *gratifying* to report the receipt of the following communication," which was signed by the dean of one of the colleges of the university. The letter quoted brings out the information that the author of the notes in SCIENCE wrote twice to the university protesting against the giving of the announced lecture on "Brains," with the result that the university president requested the literary society to cancel the lecture, which was forthwith done.

Now the fundamental consideration in the above-mentioned incident is not whether phrenology is a science, or whether it has any scientific basis, or even whether intelligent people should take note of it, but rather it is a *question* of the advisability of preventing, so far as possible, the expression before college students of views not generally believed by scientists. This lecture, be it noted, had no special sanction of the university, but was a private venture by a group of students in one of their own organizations. Certain it is that a phrenologist has a right to be heard and students not only have a right to hear, but they should be urged to, rather than hindered from, a careful investigation into the errors of any system. If the scientific facts opposed to phrenology are not strong enough to convince people of the fallacies of the subject, then surely no one has a right to prevent the expression of such ideas; and if the scientific facts are all opposed to the phrenological interpretation, then the artificial opposition on basis of authority is entirely useless as well as entirely unscientific. It may be argued that phrenology is not a modern, *scientific* theory, but an *outworn* superstition and hence should be discouraged. Without doubt superstitions should be discouraged, not by power of authority, but by scientific facts. Moreover, that which seems to be an outworn superstition may, in another form, appear later as a scientific theory, as for instance, the idea of the transmutation of metals. A few years ago a lecture on the "Transmutation of Elements" would no doubt have found many objectors who would have said that students should not have such foolish ideas placed before them. Now, however, such a lecture would be listened to with great interest because some scientists of high reputation vouch for the possibility of such transmutation. No idea should be smothered except by facts, for all the authority in the world, without good foundation of fact, may be as entirely wrong as the unauthorized idea expressed by the least known student. Further than this also we must go. Any idea, no matter how foolish it may appear, is worthy of attention as a means of stimulating thought and may even have a germ of truth which may develop into more truth by patient investigation. Let us demolish all superstitions as rapidly as possibly by the accumulation of scientific facts, but let us not hinder any propaganda by power of authority. College students should be encouraged to find out all the theories concerning any set of facts and then be led to a careful balancing of these by processes of logical thought.

ERNEST SHAW REYNOLDS

QUOTATIONS

WAR BREAD

THE public has been led to feel some anxiety concerning the effects of the present war bread upon national health and efficiency. Suggestion plays an inevitable part in such a connection. Certain untoward symptoms in individuals, for which some other tangible cause is not immediately evident, are liable just now to be ascribed on the slenderest evidence to the bread eaten. Once the belief in a deleterious influence has arisen, it is easy to understand how widely it may spread by suggestion. In the opinion of those best qualified to know, there would seem to be little basis for any such condemnation of the bread. It rests, nevertheless, with the food controller to obtain the best possible evidence concerning the facts, and we are glad to know that Lord Rhondda and the wheat commissioners have empowered a committee of the Royal Society to make a full and thorough investigation. This committee comprises some eminent medical consultants, as well as the physiologists who have been serving on the main food committee of the society. Its task is to decide whether the higher extraction of the grain can in itself be held responsible for any disturbance of health, and whether the admixture of other cereals with the wheat has produced a less digestible loaf, owing, for instance, to the associated difficulties in milling and baking.

Among other matters which are also engaging the attention of the committee is a greater tendency to "rope" in the bread, alleged to be due to the higher extraction of the grain. The habits of *Bacillus mesentericus*, which, in its various strains, is responsible for ropy bread, are already well known to bacteriologists, and, empirically at least, to all the better informed among practical bakers. There is no reason to doubt that with the increased knowledge now being acquired any outbreaks of rope will in the future be easily controlled. That the presence in the loaf of cereals other than wheat can be directly harmful is most unlikely. A favorable effect should indeed be seen in a somewhat improved balance in the protein supplied. Maize, it is true, is said to be badly tolerated by certain individuals, though such cases must be rare. It is also stated that the starch of maize is not fully gelatinized when it is cooked in admixture with wheat under conditions suitable for the production of an all-wheat loaf.

These and other points will doubtless receive the attention of the investigating committee. Its most important task, however, will be to decide, by a thorough sifting of the evidence, the more general question as to whether the war bread is, as a matter of fact, producing any ill effects at all upon the public health. The public will be glad to know that the food controller is in possession of the facts.

Meanwhile, since it is of the utmost importance to the nation that a full supply of bread shall be maintained, while the amount of wheat available is not sufficient for the purpose, we are glad to observe that the medical press is urging the profession to see that the privilege of obtaining high-grade wheat flour for cases supposed to have suffered from the war bread is at any rate not abused.—*Nature.*

SCIENTIFIC BOOKS

The Human Worth of Rigorous Thinking. Essays and Addresses. By Cassius J. Keyser, Ph.D., LL.D., Adrain Professor of Mathematics, Columbia University. The Columbia University Press. 1916. Pp. vi + 314.

Six of the fifteen chapters of this volume appeared in Science during recent years,[1] while the remaining nine chapters, together with reprints of some of the six which had first appeared in Science, were published in various other periodicals or by the Columbia University Press. Hence the volume contains nothing new. Its value is due to the convenient form in which these inspiring essays and addresses are here presented. Unfortunately it contains no index and no table of contents besides the chapter or essay headings.

The title of the volume is the same as that of the initial essay, but some of the other essays contained therein could appropriately have appeared under the same heading, while the remaining ones represent somewhat more special developments along the same general line. Hence the title indicates truthfully the subject-matter of the entire collection. The volume might appropriately have appeared also with the following title: Inspiring thoughts relating to the history, bearing and educational value of mathematics with emphasis on the philosophical elements.

The pre-eminent ability of Professor Keyser along the line of presenting the fundamental elements of abstruse subjects in an elegant and popular manner is well known. His style appeals perhaps more strongly to non-mathematicians than to the majority of the mathematicians, who are often so exclusively interested in technical mathematical questions as to be but little concerned with elegance of language and the philosophical question of human worth. Teachers of mathematics should, however, bear in mind that to many of their students technical mathematical questions have little charm, and that some of these students could doubtless be reached by the more subtle but no less real historical and philosophical questions connected with their subjects.

Hence the volume before us can be highly recommended for the prospective teachers of mathematics, as well as for those who are interested in the general cultural values of various scientific subjects. The professional mathematician will, however, also find therein much that is presented from a somewhat new point of view and that throws new light on the philosophical questions which permeate the various mathematical developments. Among the chapters which might appeal especially to such readers we may mention those bearing the following headings: "The axiom of infinity," "Mathematical productivity in the United States," and "Concerning multiple interpretations of postulate systems and the 'existence' of hyperspace."

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[1] On page 220 it is stated that Chapter XII., on the "Principia Mathematica," had been printed in Vol. XXV. of Science. It actually had appeared in Vol. XXXV., 1912, and Vol. XXXVII., 1913.

In Chapter IX. Professor Keyser discusses "Graduate mathematical instruction for graduate students not intending to become mathematicians," arguing that such courses need not presuppose a first course in calculus, but could be based upon the mathematical preparation gained in a year of collegiate study. He would begin such a course "with an exposition of the nature and function of postulate systems and of the great rôle such systems have always played in the science, especially in the illustrious period of Greek mathematics and even more consciously and elaborately in our own time."

The headings of the nine chapters which have not been mentioned in what precedes are as follows: "The human significance of mathematics," "The humanization of the teaching of mathematics," "The walls of the world; or concerning the figure and the dimensions of the universe of space," "Mathematical emancipation; dimensionality and hyperspace," "The universe and beyond; the existence of the hypercosmic," "The permanent basis of a liberal education," "The source and function of a university," "Research in American universities," and "Mathematics."

Some of these titles are the subjects of addresses delivered by Professor Keyser before large audiences, and many of those who recall his stimulating language will doubtless welcome the opportunity to secure a collection covering such a wide scope of interests which are common to all, but which should appeal especially to those devoted to the borderland between philosophy and mathematics. One finds here a mixture of the most modern theories and the emotional descriptions of past generations, a charming flow of language illuminating most recent advances and, above all, an inspiring tableland of thought which is easily accessible to all but which is closely related with fundamental questions of education.

The mathematicians, as a class, are perhaps too much inclined to put off the historic, philosophic and didactic questions for later consideration, following the example of the great mathematical encyclopedias which are in course of publication. As a result the majority of them become so engrossed in the technical developments of their subjects as to find little time for the postponed questions of the most fundamental importance—a fate which seemed to threaten the encyclopedias just mentioned. A work in which some of these fundamental questions are handled in an attractive manner is therefore a valuable and timely addition to the mathematical literature.

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EQUATIONS AS STATEMENTS ABOUT THINGS

IN the teaching of elementary physics and mathematics, much trouble is often caused by the fact that students who can readily solve an equation given them are unable to formulate in mathematical terms the data occurring in a practical problem. The purpose of this paper is to report briefly the results of several years' experience with a plan designed to remove as much as possible of this trouble by making the equations show more readily their meanings as shorthand statements of the facts. While there is probably nothing about these ideas that has not been suggested before, such suggestions, when applied at all to teaching, seem to have been rather vague and incomplete, or else applied only to one branch of the subject. In this case the plan to be outlined has been used in a general course of physics and in a course in mechanics, with results much more satisfactory than those obtained by the ordinary method.

To illustrate the difference between the old plan and the new, let us consider a single equation, the falling body law

$$s = \tfrac{1}{2} gt^2.$$

On the old plan, such an equation is merely a set of instructions for the computation of s. If the body has fallen three seconds, the student is expected on the old plan to write

$$s = \tfrac{1}{2} \times 32 \times 3^2 = 144.$$

This process, simple as it appears to the teacher, is not so simple for the student, as it really involves identifying t as the *number of seconds* the body has fallen, g as the *number of ft./sec.*^{2} in the gravity acceleration, performing the computation and then interpreting the result as a *number of feet*. One obvious cause of trouble is the necessity for using certain definite units on each side, with the errors made by the use of the wrong units; and another, perhaps not so obvious, is the fact that the formula itself is not a statement about a real distance of so many feet, a real acceleration of so many ft./sec.^{2} and a real time of so many seconds, but about pure numbers, mere incomplete "so many s," the most abstract things yet invented by man. Under these conditions is it surprising that a freshman fails to formulate his data into mathematical equations?

On the new plan, the equation is taken as a statement about actual concrete things. In this particular case, the computation would take the form,

$$s = \tfrac{1}{2} \times 32 \frac{\text{ft.}}{\text{sec.}^2} \times 3^2 \text{ sec.}^2 = 144 \text{ ft.}$$

The interpretation of the formula is now that s is physically a result of the combination of the gravity acceleration g with the time t, which enters once in producing the final velocity gt, and mean velocity $\tfrac{1}{2}gt$ and again in combination with this mean velocity to give the distance $\tfrac{1}{2}gt^2$. The essential feature in the application of this plan is the insertion of each quantity as a *quantity*, that is, as *so many times another quantity of the same kind*, and not as a mere "so many."

If in computation the boy should happen to forget to square t, he would get

$$s = \tfrac{1}{2} \times 32 \frac{\text{ft.}}{\text{sec.}^2} \times 3 \text{ sec.} = 48 \frac{\text{ft.}}{\text{sec.}},$$

an obviously impossible *kind* of answer. But if he departs from the above method only in calling $t = \frac{1}{20}$ min., he gets

$$s = \tfrac{1}{2} \times 32 \frac{\text{ft.}}{\text{sec.}^2} \times \frac{1}{20^2} \text{ min.}^2 = \frac{1 \text{ ft}}{25} \frac{\text{min.}^2}{\text{sec.}^2}.$$

To reduce this to simpler terms he has only to substitute 60^2 sec^2 *for* min^2, exactly as he would perform any other algebraic substitution of equals, and then cancel the sec^2 and finish the computation. Or, if he lets

$$g = 22 \frac{\text{min.}}{\text{hr. sec.}},$$

he gets

$$s = \tfrac{1}{2} \times 22 \frac{\text{min.}}{\text{hr sec.}} \times 3^2 \text{ sec.}^2$$

$$= \tfrac{1}{2} \times 22 \frac{\text{min.}}{3600 \text{ sec.}^2} \times 3^2 \text{ sec}^2 = \tfrac{11}{400} \text{ min},$$

which is as correct an answer as the other. To reduce units the game is simply to substitute equals for equals and cancel. If this does not give the right kind of an answer, it is a sure indication of an error.

Of course, to play the game fairly, we must abolish formulas with lost units, such as $s = 16t^2$. Examples of these are found most frequently in electricity. The old plan would write such a formula as that for the force on a wire in a magnetic field, as $F = IlH$ with a string of restrictions on units, or $F = \frac{1}{10} IlH$ with another string. By forgetting the restrictions and using the simpler formula with the most familiar units, the students often achieve remarkable results. On the new plan this would be written $F = KIlH$ where

$$K = \frac{1}{10} \frac{\text{dyne}}{\text{amp. cm. gauss.}}$$

and all restrictions are removed. It is of of course true that this form of the equation involves more writing than the others; indeed, it may be noted here that the process of treating all equations as physical statements is not necessarily worth while for trained men doing routine computations, but it is extremely useful for all sorts of cases where the computations are not familiar enough to be classified as routine work. For all such cases it is well worth while to write out the proportionality constant, especially if some one is likely to want l, say, in inches or F in kilograms.

In the detailed application of this principle, there is one point where confusion might arise, though it can readily be avoided. It is the anomalous behavior of the unit, radian, which appears as a perfectly respectable unit when an angular velocity is converted from $\frac{\text{rev}}{\text{min}}$ to $\frac{\text{sec}}{\text{rad}}$ but does not appear when the same angular velocity is found from $\frac{v}{r}$. This anomaly is the only one of its kind, and is not nature's fault, but our own. If we define angle as degree of opening, to be measured in units of the same kind, the substitution method outlined above is the most natural method of converting say $\frac{\text{rev}}{\text{min}}$ to $\frac{\text{rad}}{\text{sec}}$. If, on the other hand, we define angle as a mere ratio of arc to radius it is necessarily a pure number (like a sine or a tangent). If we swap horses in midstream, we shall either miss this unit later or else see it floating up where we do not expect it. This means we must insert or rub out the unit radian whenever it is convenient to do so. Fortunately angle is the only quantity treated in such a way.

For the sake of such mathematical purists as may not approve of the above on philosophical grounds, a few words should be inserted here on the meaning of the term "multiplication." In elementary arithmetic it means merely repeated addition, but with the introduction of irrational numbers the term is extended by mathematicians to an operation that is not strictly repeated addition. The plan here advocated extends the notion of multiplication still further, to cover a physical combination of concrete quantities. In general the definition of multiplication in each individual case amounts to translating into algebra the ordinary verbal definition of the compound quantity involved (area, velocity, work, etc.). This extension is made practicable by the fact that the operation thus defined obeys the same logical postulates as the corresponding algebraic operation on pure numbers. In other words, the machinery of mathematics can be applied not merely to numbers, but to any group of concepts and operations satisfying the same postulates. This fact is accepted intuitively by most students; and incidentally the emphasis it puts on the definitions prevents most of the well-known confusion between acceleration and velocity, power and work, and so on.

To sum up, it seems to me after several years' experience with this system, that it has the following important advantages: (1) It treats equations as neat shorthand statements about real physical things and emphasizes the esthetic side of mathematics in general; (2) It provides an enlarged principle of dimensions by which equations may be checked during computation; and (3) It removes completely all restrictions on the units to be used and enables the student to concentrate his attention on the facts of nature without the disturbing influence of arbitrary rules.

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SPECIAL ARTICLES

ON THE SWELLING AND "SOLUTION" OF PROTEIN IN POLYBASIC ACIDS AND THEIR SALTS

There are available only scattered observations on the absorption of water by proteins in the presence of various polybasic acids and their salts In order to obtain further experimental data in this field, we undertook a rather detailed study of this problem during the past year. As examples of proteins, dried gelatin discs and powdered fibrin were used. For the polybasic acids we chose phosphoric, citric and carbonic. In connection with the swelling of gelatin, we studied also its "solution." The general results of our experiments may be summed up as follows.

I

The amounts of water absorbed by gelatin from equimolar solutions of monosodium, disodium and trisodium phosphate depend not only upon which of these salts are present, but upon their concentration. Gelatin absorbs but little more water in a solution of monosodium phosphate than it does in pure water.

In low concentrations of disodium phosphate, gelatin swells decidedly more than in pure water, but as these lower concentrations give way to higher ones, the gelatin swells less and less until, when sufficiently high concentrations are attained, the gelatin swells decidedly less than in pure water.

These same general truths may be stated for trisodium phosphate, except that the absolute amounts of water absorbed in solutions of this salt are, at the same molar concentration, decidedly higher than in the case of the disodium salt. Low concentrations of trisodium phosphate bring about much greater swelling than higher ones. With progressive increase in the concentration of the trisodium salt, there is a progressive decrease in the amount of swelling until a concentration is finally reached in which the swelling is decidedly less than in pure water.

Having studied in this fashion the relation of swelling to type of salt and its concentration, we investigated next the amount of water absorbed by gelatin in phosphate mixtures of compositions varying from the extreme of pure phosphoric acid on the one hand through mono-, di- and trisodium phosphate to pure sodium hydroxid on the other. These mixtures were made in different ways. Beginning with pure phosphoric acid, we added successively greater quantities of sodium hydroxid, or beginning with sodium hydroxid, we added successively greater amounts of acid until the theoretical neutralization had been accomplished; or we began with pure acid and replaced this with more and more of the mono- di-, or trisodium phosphate until the opposite extreme of a pure alkali was reached; or we began with a definite concentration of any one of the phosphates and added progressively greater amounts of either acid or alkali. The results in all these exprimeents were practically the same. In 24 to 48 hours the gelatin attained its maximal swelling (practically). When the amount of swelling is plotted on the vertical and the changes in the composition of the solutions from acid through the mixtures of the mono-, di- and trisodium salts to pure alkali on the horizontal, a curve, roughly V-shaped, is obtained. Greatest swelling is observed in the pure acid solution and least in a solution consisting essentially of monosodium phosphate. From this point on, there is a gradual increase in the swelling of the gelatin until the disodium salt is passed, when there occurs a more abrupt rise until the trisodium salt is reached, beyond which the curve rises still more steeply until the sodium hydroxid end of the series is attained.

The swelling of gelatin in monosodium, disodium and trisodium citrate follows the same general laws as its swelling in the corresponding salts of phosphoric acid. Monosodium citrate in all concentrations increases somewhat the swelling of gelatin over the amount of swelling in pure water. The same is true of low concentrations of disodium citrate. But the higher concentrations of this salt depress the swelling to below that attained in pure water. These statements also hold for the trisodium salt. As we succeed in getting more base into the citrate, there appears a distinctly greater tendency to depress the amount of water absorption.

In studying the amounts of water absorbed in citrate mixtures varying between the extreme, on the one hand, of pure citric acid, through mono-, di- and trisodium citrate to pure sodium hydroxid, we observed that the results (when amount of swelling is plotted on the vertical and progressive change in composition of solution on the horizontal) yield a U-shaped curve. Greatest swelling is obtained in the pure acid, the amount of this swelling decreasing progressively as we approach the monosodium salt. From the monosodium to the disodium salt the curve falls more gently, until a minimal point is reached in a mixture of about equal parts of monosodium citrate and disodium citrate. From here on, the curve rises gradually to the trisodium salt, after which it ascends steeply as we pass toward the extreme of the pure alkali.

We have also studied in this fashion the effects of carbonate mixtures. As the sodium bicarbonate in a pure solution of this salt is gradually displaced by a molecularly equivalent amount of sodium carbonate, and this in its turn by an equivalent of sodium hydroxid, the amount of water absorbed gradually increases in the form of the right arm of the letter U. Swelling is least in the pure sodium bicarbonate, increases slowly in the sodium carbonate and then more rapidly as this is replaced by sodium hydroxid. The swelling of gelatin in pure sodium bicarbonate is slightly higher, in the concentration employed by us, than in pure water.

II

Practically the same findings as have been detailed for gelatin in the paragraphs given above were encountered when the swelling of fibrin was studied in different concentrations of the pure salts or in mixtures of these, varying between the extremes of acid on the one hand and alkali on the other.

III

It has been pointed out in previous papers[1] that the swelling of a protein and its liquefaction or "solution" are totally different processes. The "solution" of gelatin is, in other words, not merely the extreme or a continuation of the swelling of a protein. We were able to verify these results in studying, in parallel with the swelling of gelatin in polybasic acids and their salts, its "solution" under the same circumstances.

When gelatin containing a unit amount of water, and solid at ordinary room temperature, has mixed with it phosphoric acid, phosphate mixtures or sodium hydroxid in the concentrations already discussed above, it is found that the "solution" or liquefaction of the gelatin parallels its swelling. In other words, gelatin remains solid in phosphate mixtures of various kinds, but tends to lose in viscosity, to liquefy and to remain fluid as we pass from the phosphates in the direction either toward acid or toward alkali.

IV

We hold these experiments to be corroborative of, and to bear upon notions previously expressed regarding the importance of acids, of alkalies, of various salts and of these in mixture in determining the amount of water absorbed by protoplasm under physiological and pathological conditions. The well-established qualitative and quantitative analogy between the absorption of water by various hydrophilic colloids (like the proteins) and isolated cells, organs or organisms, whether of animal or vegetable origin, shows that protoplasmic water absorption is essentially a colloid-chemical phenomenon. These studies with polybasic acids and their salts therefore bring further proof of the importance of an abnormal production or accumulation of acids within such colloid systems for increasing the amount of water thus held, and so of explaining the mechanism by which the abnormally high hydrations of living cells are brought about as observed in edema, excessive turgor and plasmoptysis, or in those various "diseases" which are in essence only edemas of the involved organs like nephritis, glaucoma and "uremia." These experiments also show how coincident with, but not synonymous with the increased swelling there also occur a "softening"[2] and an increased "solution" of the colloids of the involved tissues, thus explaining further the "softening" of organs after an initial swelling together with the appearance of increased amounts of colloid (like protein) in the fluids bathing or expressed from the involved edematous tissues (albuminuria, excessive protein content of spinal fluid in edemas of the central nervous system, increased protein content of serous accumulations, etc.).

Martin H. Fischer,
Marian O. Hooker,
Martin Benzinger,
Ward D. Coffman
Eichberg Laboratory of Physiology,
University of Cincinnati,
May 30, 1917

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[1] Martin H. Fischer, Science, N. S., Vol. XLII., p. 223 (1915); *Kolloid Zeitschr.*, Vol. XVII., p. 1 (1915).

[2] For a discussion of tissue softening as due to the breaking of an emulsion see Martin H. Fischer and Marian O. Hooker, Science, N. S., Vol. XLIII, p. 468 (1916); "Fats and Fatty Degeneration," 76, New York, 1917.

NOTES ON MITES ATTACKING ORCHARD AND FIELD CROPS IN UTAH[1]

During the summers of 1915 and 1916 while making investigations for the laboratory of the American Smelting & Refining Company, Department of Agricultural Investigations, I found certain mites to be particularly abundant and destructive to grains in Utah.

The most important of these was the common *Tetranychus bimaculatus* Harvey, which Ewing believes is the same as *T. telarius* Linn. The host list for this species, as Ewing has pointed out, is a long one, and it is an important pest on a surprisingly large number of crops. In 1916 it was so abundant in orchards that many cherry trees were completely defoliated before the end of August, and apricot, pear, plum and apple trees were only a little less seriously affected. Raspberry and currant bushes suffered severely, some of them losing all of their leaves. Peas, beans, tomatoes and other kinds of garden truck showed more or less injury in all stages of their development, and in one field of sugar beets, I found many leaves drying and turning brown on account of the attacks of this mite. The loss of the foliage of many ornamental plants, while not of so much economic importance, was, of course, a very annoying thing.

Corn probably suffered more than any other field crop. In many fields practically every plant suffered the loss of some of its leaves, and in other places all of the leaves turned brown and became thoroughly dry because of the presence of the myriads of mites that covered the undersides of the leaves. The parts of the fields where the soil was lighter and dryer usually suffered most, but no parts seemed to be immune from the attacks of this pest. The suckers and lower leaves were the first to be attacked and to show the brown spots or streaks where colonies of the mites were feeding. When the trouble went no further it was of but little economic importance, but when the upper leaves were attacked and practically all destroyed the plant withered and was not even good for fodder.

Many wheat fields also sustained considerable losses due to the attacks of the same mite. The wheat plants would usually be attacked a short time before the head burst from the sheath and when the infestation was bad the leaves would become dry and brown at the point of attack and the portion of the leaf beyond this would droop down and dry out. Often all of the leaves would be affected in this way and the heads, if they developed at all, would be small and poorly filled.

Earlier in the season, while the wheat plants were much smaller, they were often attacked by two other species of mites. One of these is the well-known clover mite, *Bryobia pratensis*. The other has been called the jumping mite on account of its habit of quickly folding its legs and dropping from the plant when disturbed. Banks in *Proc. Ent. Soc. Wash.*, Vol. 14, p. 97, named this species *Tetranychus longipes*. A letter dated June 29, 1915, says that he now places it with two others in a new genus, *Tetranobia*. He refers to this genus again in his bulletin on "The Acarina or Mites" (Rept. No. 108, U. S. Dept. Agric. Office of Sec., pp. 33 and 38) but the formal description of the genus has not yet been published. The common name, jumping mite, is somewhat misleading, for the mite does not actually jump, but, when alarmed, it folds its legs quickly and may thus be thrown a short distance from the spot where it was feeding. In fields where the mite is abundant the leaves turn distinctly gray and many of them become so dry that the growth of the plant is seriously affected. Both *B. pratensis* and *Tetranobia longipes* were found destructively abundant not only on wheat, but on barley, oats and many wild grasses.

R. W. Doane

Stanford University

THE OCCURRENCE OF MANNITE IN SILAGE AND ITS POSSIBLE UTILIZATION IN THE MANUFACTURE OF EXPLOSIVES

During the course of our investigations on the fermentation processes that occur immediately after the ensiling of corn, and the chemical products resulting therefrom, it was found that mannite could be isolated from practically every sample of normal corn silage. The alcoholic extract from dried silage yielded, on evaporation, considerable amounts of mannite, which after one recrystallization gave the characteristic crystals melting at 168–169°. That the presence of mannite can not be considered a local phenomenon is shown by the fact that silage samples obtained from a number of other states in the middle west all contained mannite. The only previous reference to the occurrence of mannite in silage is in a paper by Manns,[1] published a quarter of a century ago. In his work, however, only one sample of silage was examined and the approximate amount of mannite found was not stated.

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[1] Contribution from the laboratories of the American Smelting and Refining Co., Department of Agricultural Investigations.

The following table shows the amount of mannite actually isolated by us from samples of silage obtained from various sources:

Date	Source	Material	Mannite. (Per Cent. on Air-dry Basis)
Feb. 20	Iowa	Corn silage juice	1.30
Mar. 14	Wisconsin	Corn silage	1.70
Mar. 20	Nebraska	Corn silage	2.07
Mar. 21	Minnesota	Corn silage	2.51
Mar 27	Minnesota	Corn silage	1.47
Mar 27	Illinois	Corn silage	2.15
Mar 28	Missouri	Silage from immature corn	0.52
Mar. 20	Kansas	Cane silage	3.30
May 17	Montana	Sunflower silage	5.61
Apr. 16	Arkansas	Corn and cowpea silage	none
Mar. 2	Illinois	Sweet clover silage	none
May 11	Iowa	Ensiled corn stover + sucrose 30 days	3.04
Feb. 21	Iowa	Ensiled corn stover + sucrose 13 days	2.12
May 27	Iowa	Ensiled green corn 10 days	1.72
Feb. 21	Iowa	Ensiled corn stover + glucose 30 days	none

It will be noted that the highest percentages of mannite are to be found in the sunflower silage, the cane silage and the experimental corn silage to which sucrose had been added. Evidently the mother substance of the mannite is sucrose, or more specifically its fructose moiety.

The production of mannite no doubt reaches a maximum soon after filling the silo and then some loss probably occurs, owing to further bacterial activities. However, the amount of mannite is still considerable when the silage is several months old.

If it is desired to prepare quantities of mannite without reference to an approximately quantitative yield, the method may be much simplified. The silage is put in a powerful press, the juice filtered, evaporated to about one sixth of its volume and two or three volumes of alcohol added. The mannite then crystallizes out, and the alcohol can be recovered in the usual way. In this manner it should be possible to extract the mannite on a large scale at very little cost. The pressed residue and the mother liquor could be combined and used for feeding in place of the original silage, since practically nothing would be removed but the mannite and the volatile acids.

Mannite yields a nitration product very similar in properties to nitroglycerin. According to Sanford,[2] "Nitromannite is more dangerous than nitroglycerin, as it is more sensitive to shock. It is intermediate in its shattering properties between nitroglycerin and fulminate of mercury. . . . It is not manufactured upon the commercial scale."

The reason nitromannite is not made commercially is probably the prohibitive cost of mannite. Prepared by the above method from silage, mannite should be even cheaper than glycerin, especially if the residues are utilized as cattle feed. The thousands of tons of silage used every year by the farmers of this country could be made to yield a valuable by-product if treated by this simple process.

Arthur W. Dox,
G. P. Plaisance
Iowa Agricultural Experiment Station

THE NORTH CAROLINA ACADEMY OF SCIENCE

The sixteenth annual meeting of the North Carolina Academy of Science was held at the University of North Carolina on Friday and Saturday, April 27 and 28, 1917. At 2:30 P.M. the executive committee met, passed on the report of the secretary-treasurer, elected 10 new members, and selected the State Normal College, Greensboro, as the next place of meeting. At 3 P.M. the reading of papers was begun and continued until 5:30, when adjournment was had. Reconvening at 8 P.M., the academy was welcomed to the university by Dean Andrew H. Patterson, after which President F. P. Venable, of the academy, delivered his presidential address, "The structure of the atom." Next Professor Collier Cobb gave a lecture on "Typical early maps of North Carolina" illustrated by lantern slides of some of the maps in question. The academy then adjourned to the hospitable home of Professor W. C. Coker for a highly enjoyable smoker.

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[1] Illinois Ag. Exp. Sta. Bulletin, No. 7, pp. 190–193.

[2] Nitro-Explosives, p. 110, D. Van Nostrand Co., 1906.

The annual business meeting of the academy was held at 9·15 Saturday morning. Reports of the secretary-treasurer, the executive and other committees were made. On motion a committee was appointed to cooperate with a similar committee from the Science Section of the North Carolina State Teachers' Association in studying the subject of the teaching of high-school sciences in the state with reference to its increased efficiency. The secretary reported on his visit to the meeting of the Southern Association of Colleges and Secondary Schools and his appearance in behalf of the work in science before its committee on the curriculum of secondary schools. On motion, the secretary was again appointed as the representative of the academy at the next meeting of this association. After some discussion it was declared the sense of the meeting that an increased effort be made in 1918 to bring into the membership of the academy as many as possible of the high-school teachers of science in the state.

The following officers were elected for 1917-18:

President—W. A. Withers, State Agricultural and Engineering College, West Raleigh.

Vice-president—J. H. Pratt, University of North Carolina, Chapel Hill.

Secretary-treasurer—E. W. Gudger, State Normal College, Greensboro.

Additional members executive committee—Bert Cunningham, High School, Durham; H. R. Totten, University of North Carolina, Chapel Hill; H. C. Beardslee, Asheville School, Asheville.

At 10:50 a joint meeting was held of the academy and the North Carolina Section of the American Chemical Society for the reading of the papers of common interest to both bodies. Following this, papers were read before the academy until the program was finished at 1:40, when the members were entertained by the university at luncheon in Swain Hall. Of the 20 papers on the program not one was read by title. Counting the 10 new members, the total membership of the academy is 84, of whom 37 were present at this meeting. Including the presidential address, which will be published in the current number of the *Journal of the Elisha Mitchell Scientific Society*, the following papers were read:

Pliocene deposits in Orange county: JOHN E. SMITH.

These occur on the divides and on the higher terraces in the plateau section of the county and generally over the Triassic area except on the floodplains and on the steeper slopes near the streams.

On the upland (elevation, 500–600 feet) this material consists of smooth, rounded pebbles and cobbles (some of which are polished) of quartz and quartzose minerals up to six inches or more in diameter, together with fragments of the same and of other minerals down to the size of soil particles. In the Triassic area (elevation, 250–400 feet) the deposit comprises gravel, sand and soil (in addition to the above) in some places reaching a thickness of a foot or more. This material has been transported from a distance and characterizes the Granville soils, distinguishing them from those of the Penn series, which are derived from the Triassic rocks in place.

The thinly distributed pebbles on the higher divides of the county may be remnants of river deposits on a peneplain, but the soils, etc, of the lower interstream areas are doubtless of Lafayette age. (Illustrated with lantern slides.)

The pollination of Rotundifolia grapes: L. R. DETJEN.

A close examination of the flowers of *Vitis rotundifolia* brings out the fact that this species of grape is not at all adapted to cross-pollination by means of the wind; on the contrary, it seems to indicate that insects alone are responsible for the transportation of the pollen. Bees of the family Andrenidæ and beetles of the species *Chauliognathus marginatus* were tested for their propensities of transporting pollen and for the searching for flowers of the fruit-bearing varieties.

The test was made by enclosing insects, newly captured on flowers of staminate vines, separately in spacious cloth bags together with clusters of open but unpollinated flowers. The results secured substantiate the hypothesis of insect pollination. They further indicate that bees of the family Andrenidæ are probably the most effective pollinators of the vine and that beetles are of only minor importance. Bees of the family Megachilidæ are also active workers and undoubtedly contribute considerably toward the production of fruit.

Saprolegnia anisospora in America: W. C. Coker.

This species has not before been reported in America. We have found it twice in Chapel Hill, in marshy shaded places containing algæ. It is distinguished chiefly by the following characters:

1. The presence of spores of two or three sizes, borne usually in separate sporangia without regard to the size of the latter; the small spores from 10.5–11 μ in diameter, the large ones from 13.7–14 8 μ in diameter. In nearly all cultures there are formed a few very large spores, at least twice the size of the ordinary large ones, these appearing mixed in with the latter.

2. The irregular shape of the sporangia, which are not evenly cylindrical, but more or less waved, bent and constricted, and which proliferate either laterally from below as in *Achlya*, or within the old ones, as is usual in *Saprolegnia*.

3. In sexual reproduction numerous oogonia are formed, each with one or more antheridia of diclinous origin.

The jaws of the great barracuda, Sphyræna barracuda: E W. Gudger.

A careful description, illustrated by photographs and a specimen, was given of the teeth and jaws of this fish. Their use was briefly described and some accounts of the ferocity of the fish narrated. In the waters of southern Florida it is generally more feared than the shark, being bold and inquisitive where the shark is cowardly. The data presented are part of a paper now in press in a volume of memoirs from the Tortugas Laboratory of the Carnegie Institution at Washington.

The status of the science work in the high schools of North Carolina (lantern): S. J. Marion.

This survey and report will be published in full in the forthcoming issue of the *North Carolina High School Bulletin*.

Armillaria mellea, Clitocybe cespitosa, Pleurotus sapidus and Claudopus nidulans in pure culture: H. R. Totten.

The fact that the spores of *Armillaria mellea* and *Clitocybe cespitosa* (*C. monodelpha*) have two walls, while the spores of *Pleurotus sapidus* and *Claudopus nidulans* have only one wall is plainly shown in the sprouting spores. Mycelia of the four mushrooms were shown in pure culture on several media, also drawings of the mycelial threads as seen under high power. *Armillaria mellea* forms a slow-growing, closely flocculent, cream-colored mat, and soon produces long, brown to black, root-like rhizomorphs. In agar these rhizomorphs are beautifully shown radiating from the mat-like central mass. The mycelium of *Clitocybe cespitosa* is much like that of *Armillaria mellea*, but the threads are not so closely woven and the rhizomorphs, or root-like bodies, are white. It is shown that *Armillaria mellea* and *Clitocybe cespitosa*, while very closely related, are not the same. The mycelium of *Claudopus nidulans* is silkier and is from white to pink in color. The mycelium of *Pleurotus sapidus* except in old cultures is loose and silky and is very fast growing, soon covering the medium with a mass of pure white threads. Fruiting bodies of both *Pleurotus sapidus* and *Claudopus nidulans* were shown developing in pure cultures.

Structural geology of Orange county, N. C.: John E. Smith.

With few exceptions the rocks of this county occur in long, narrow belts and "islands" extending north 65° east. Named in their order from the southeast these areas comprise the Triassic sedimentaries, granite, diorite, rhyolite, schists and greenstone, diorite, schists and phyllite, greenstone and schists, diorite, schists and greenstone, diorite, granite.

The structure of these rocks is that of a syncline whose trough centers along the line of strike and passes near Cheek's Siding about three miles east of Mebane. Measured along the dip this syncline is approximately twenty miles wide and probably contains folds of minor importance within it. The major joints, flow lines, etc., of the igneous rocks in many places parallel both the dip and the strike of the schists belts. Inclusions of the diorite in the granite attest the greater age of the former and the presence of belts of igneous rocks beneath the margins of the syncline certify their contribution to the structure and prove the greater age of the schists, etc. South of Chapel Hill beyond Morgan Creek the strike is due east and west and the conglomerates, slates and rhyolites dip to the south at an angle of 65°. (Illustrated with maps, charts and structure sections.)

State regulation of the sale and manufacture of gas: C. W. Edwards.

In 1910, out of 228 cities in the United States of more than 25,000 population, only 47 had no requirements such as are in a bill proposed for North Carolina. Of these 228 cities, 103 are under state laws and have no additional municipal regulations. A number of cities such as Baltimore, Buffalo, Los Angeles and Milwaukee have local provisions in addition to state laws. In 1910, sixteen states had laws providing for the state inspection of meters and of the purity of gas—Connecticut, Georgia, Kansas, Maryland, Massachusetts, Nevada, New Hampshire, New Jersey, New York, Ohio, Oklahoma, Vermont, Virginia, Washington, Wisconsin and California (B. of S. Circular No. 32). Doubtless the list is now larger.

In 1910 the net income to the state of Massachusetts in meter-testing alone was over $5,000. The total cost of the tests on quality, purity, pressure, etc., was assessed on the operating companies according to their sales. Meter-testing is on the fee basis. There is no good reason why such a department in North Carolina would not yield a revenue to the state.

That the Corporation Commission in North Carolina should have the power and machinery at its command to protect the interests of citizens seems obvious for the following reasons: Under existing law it is the duty of the commission to regulate the rates to be charged by gas companies. The proper price is determined in a large measure by the quality of product sold and this is almost at the will of the producer. Gas in New York City furnishes 680 heat units per cubic foot and is sold at 80 cents. Gas in Durham furnishes at times less than 500 heat units and is sold at $1.50. In one city in this state gas furnishing 412 heat units sold for $1.60. The standard requirement in regulated states is around 600 heat units. The difference in quality means a loss of from five to twenty thousand dollars per year to consumers in various towns of this state and the loss would easily run into hundreds of thousands to the state at large. While it may be to the interest of certain communities to sell a cheap, poor gas it is safe to say that it is always against public interest to have a cheap, poor gas sold at a rich, high price. To fairly meet its responsibility the commission must know from its own tests the quality of the product sold. The consumer is entirely helpless.

Aside from the question of rates, the public is vitally interested from the standpoint of health. In the method of manufacture used by one company in this state, carbon monoxide and hydrogen are produced in equal quantities. Both of these gases are odorless and one is a deadly poison. Combined they give a cheap gas furnishing about 300 heat units. This gas causes a meter to register just as fast as a 600 heat unit gas. It is the duty of this company to carburet this gas with an oil which not only brings its heat value to standard, but gives it a very pungent odor that makes it noticeable in case of a leak. In this town a series of fatal accidents have occurred due solely to the neglect of the service company. In other methods other deleterious elements are introduced by carelessness so that in all cases public interest demands systematic testing under the authority of the state.

It is just as reasonable to let manufacturers sell anything called fertilizer without tests as to composition as it is to permit of the sale of untested gas. Our duty to test meters is just as obvious as our duty to test weights and measures.

The advantages resulting from such an act would not even be principally with the citizen. An expert employed by the state to travel from plant to plant observing and testing, corrects irregularities and errors in manufacture that may mean thousands of dollars saved to the companies. If ammonia appears in the gas it means that a valuable by-product is being lost. So it is with other errors of manufacture. The fact that meters are tested by the state brings a feeling of confidence to the consumer that is worth much to the gas companies. Uniform, improved and economical manufacture brings new and profitable business and this more than compensates for any costs involved.

No abstracts have been received for the following papers:

The relative toxicity of uranium nitrate in animals of different ages, by Wm. DeB. MacNider.

Trembles, by Frederick A. Wolf.

Permanency in fleshy fungi, by H. C. Beardslee.

Sound-wave photography (lantern), by Andrew H. Patterson.

Evolution in sponges and changes in classification, by H. V. Wilson.

The revision of the atomic weight of zirconium, by F. P. Venable and J. M. Bell.

Recent investigations about cottonseed meal, by W. A. Withers and F. E. Carruth.

The physics of the shrapnel shell, by Andrew H. Patterson.

Portolan charts (lantern), by Collier Cobb.

The idea of force in mechanics, by Andrew H. Patterson.

The times we think in, by George W. Lay.

The life history of the pecan trunk borer, by R. W. Leiby.

E. W. Gudger,
Secretary

SCIENCE

FRIDAY, AUGUST 31, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

LIEBIG'S LAW OF THE MINIMUM IN RELATION TO GENERAL BIOLOGICAL PROBLEMS[1]

THE Law of the Minimum has never been accurately defined, although the idea that it involves is relatively simple. Professor B. E. Livingston says in a recent paper[2] that "this principle is still quite incomplete logically and its statement will assuredly become much more complex as our science advances." In order to get a clear understanding of the law so that it may be stated accurately, we will begin with a simple application to chemical reactions.

One molecule of KOH reacts with one molecule of HCl to form one molecule of KCl and one of H_2O. If only one molecule of KOH is present, only one molecule of KCl can be formed, no matter how many molecules of HCl are present; and likewise if only one molecule of HCl is present, only one molecule of KCl can be formed, no matter how many molecules of KOH are present. By considering the weights of the reacting substances, the situation is somewhat complicated: 56.1 grams of KOH react with 36.5 grams of HCl to form 74.6 grams of KCl and 18 grams of H_2O. In round numbers 3 parts by weight of KOH and two of HCl give 4 parts by weight of KCl and one of H_2O: 3/4 gr. of KOH and 1/2 gr. of HCl are necessary to form a gram of KCl. Let us call these fractions, 3/4 and 1/2, the specific reactive weights of KOH and HCl in respect to the formation of a unit quantity of KCl. Suppose x amount of KOH and y of HCl are given. If x and

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[1] Paper read before the Biological Club of Yale University, April 19, 1917.

[2] *Plant World*, 20: 1-15, 1917.

y are divided by their respective specific reactive weights, we get $\frac{4}{3}x$ and $2y$. The smaller of these quantities is a direct measure of the weight of KCl that can be formed from x KOH and y HCl. If, for example, x and y are both equal to three grams, four grams of KCl can be obtained.

These facts can be generalized. If A, B and C are substances which react to form S and u A, v B and w C are necessary for the formation of a unit amount of S, then u, v and w may be called the specific reactive values of A, B and C, respectively. They may be weights, volumes, numbers of molecules or what not. In any particular case, where pA, qB and rC are reacting, the amount of S formed is the smallest of the fractions p/u, q/v, r/w. When the amounts of the reacting substances are divided by their specific reactive values, the smallest quantity so obtained is equal to the amount of the product formed.

This conclusion is directly applicable to the problem of fertilizers. It is known that most of the higher plants must obtain seven elements in combined form from the soil. They are S, P, N, K, Ca, Mg and Fe. If αS, βP, γN, δK, ϵCa, ζMg and ηFe are required for a unit amount of growth in some particular plant, say wheat, and if aS, bP, cN, dK, eCa, fMg and gFe are present in a particular soil in available form, the maximum amount of wheat that can be grown in that soil will be the smallest of the fractions a/α, b/β, c/γ, d/δ, e/ϵ, f/ζ, g/η. In this case α, β, γ, etc., may be called specific growth values for the plant under consideration. When the available amounts of the essential inorganic food constituents are divided by their respective growth values, the smallest quantity obtained gives the maximum amount of growth possible.

It was in this connection that Liebig[3] first formulated the Law of the Minimum which, as commonly stated,[4] says that "the yield of any crop always depends on that nutritive constituent which is present in minimum amount." The use of the term minimum is not strictly accurate, as can be seen from the example of KOH and HCl. If three grams of each are present, the amount of KOH determines the yield of KCl, although both HCl and KOH are present in equal amount. However, the above statement of the law is convenient because of its simplicity.

A much broader application of the Law of the Minimum was indicated by the work of F. F. Blackman, whose conclusions are summarized in his paper on "Optima and limiting factors."[5] Blackman called attention to the complexity of the process of carbon assimilation, the rate of which depends on at least six factors—

1. Temperature,
2. Light intensity,
3. Carbon-dioxide supply,
4. Water supply,
5. Chlorophyll,
6. Enzymes.

Where it is possible to vary one of these factors independently of the rest, its effect on the rate of assimilation can be measured, under suitable conditions, and a curve plotted. In this way a temperature-assimilation curve, a light-assimilation curve and a carbon-dioxide-assimilation curve can be constructed. The other factors are more difficult to control. The following curves were constructed by Blackman and Smith[6] from a study of the rate of assimilation in *Elodea*.

The light curve and the carbon-dioxide curve are straight lines. The rate of assimilation varies directly with the intensity of light and the supply of carbon dioxide. The temperature curve shows that the rate of assimilation is an exponential function of the temperature. In fact the process of assimilation obeys van't Hoff's law of reactions for temperatures under 30° C. Above this, the rate of assimilation at first rises and then falls off, the process being complicated at high temperatures by a "time factor." The same effect has been observed at high light intensities, and with strong concentrations of carbon-dioxide which have a narcotic effect.

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[3] "Die Chemie in ihre Anwendung auf Agricultur und Physiologie," 7^{te} Auflage, 2: 225, 1862.

[4] *Cf.* F. Czapek, "Biochemie der Pflanzen," 2: 841, 1905.

[5] *Annals of Botany*, 19: 281–295, 1905.

[6] *Proc. R. Soc., B.*, 83: 389–412, 1910.

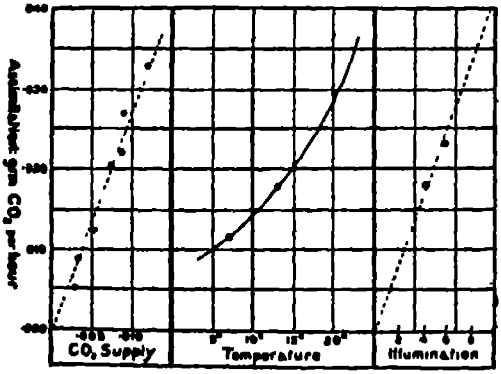

FIG. 1. Effect of external factors on assimilation in *Elodea*. (After Blackman and Smith.)

Disregarding these complications, we will confine our attention to the first parts of these curves. The ordinates of all three curves are the same, namely, rates of carbon assimilation, which can be measured in terms either of CO_2 absorbed or of sugar produced. The former happens to be the more convenient measure. At any given temperature, the rate of assimilation which is a function of that particular temperature can be determined directly by the curve and is equal to a certain distance measured off from the origin on the Y-axis. Similar distances are given for any definite supply of carbon dioxide and for any degree of illumination. In any actual environmental complex, where the temperature, light and carbon-dioxide supply are known, the rate of assimilation is equal to the shortest distance measured on the Y-axis. This is stated as a general principle by Blackman as follows: "When a process is conditioned as to its rapidity by a number of separate factors, the rate of the process is limited by the pace of the 'slowest' factor." The factor which gives the shortest distance on the Y-axis—that is, the "slowest" factor, he calls the limiting factor.

As a matter of fact the carbon assimilation of green plants is usually limited by the seasonal variation in temperature and the diurnal variation in light, the CO_2 content of the air being constant. Nothing has been said of the other factors that effect carbon assimilation—the water supply, chlorophyll and enzymes. These so-called "internal" factors, as well as the "external" factors, are governed by the Law of the Minimum. Of the internal factors, water and chlorophyll are present in excess in healthy green plants, the amount of assimilatory enzymes being the only probable limiting factor.

It is not necessary to adduce additional examples to show that the Law of the Minimum is a *universal* law, affecting not merely the concentration of reacting substances, but *all* factors that in any way influence a reaction or process. The law is applicable to physical, chemical and geological as well as biological problems.[7] An interesting instance of its application to a problem in physics is the determination of the magnitude of a thermionic current. This varies with changes in temperature, and also with changes in the voltage applied. The temperature formula gives one value, the voltage formula may give another; the lesser value determines the current flowing. The application of the Law of the Minimum has been worked out in many cases and has been of great use in the interpretation of complicated relations; but it has been recognized as a law and has been consciously applied by plant physiologists and physiological chemists only.[8] Without doubt it can be used to advantage in many problems of the physiology, morphology and ecology of both plants and animals.

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[7] A timely application may be made which is worth bearing in mind. The efficiency of a nation at war is subject to the Law of the Minimum. Defeat, in the last analysis, may be attributed to the effect of some limiting factor.

The Law of the Minimum must be taken into account in all experimental work, for which it serves both as a precaution and a guide.[9] When investigating the effect of an external factor such as temperature, light, etc., on any given process, it is necessary to keep all other variable factors constant, and then to determine the effect of changes in the factor under consideration. What results might be obtained when this method is used in studying carbon assimilation? Suppose the CO_2 supply and the light are kept constant, while the temperature is varied. If the CO_2 supply is such that it becomes a limiting factor when the temperature rises above 10° C. then the rate of assimilation will rise with the temperature up to this point, but will remain constant at all higher temperatures, until the destructive effect of the high temperature is manifested and the curve again falls off. Above 10° C. variations in the temperature have no apparent effect under these experimental conditions. But if the CO_2 supply is increased so as to permit more rapid assimilation, then the temperature curve can be extended. Negative results from such an experimental method are therefore without significance. It is not enough that the experiment be conducted under constant conditions; the constant factors must not interfere in any way with the carrying out of the process; that is, they must not be limiting factors. On the other hand, it is a simple matter to determine by the shape of the curve whether any other factor than the one under investigation is a limiting factor. Such is always the case when a break occurs in the curve; usually the curve rises at first and later runs parallel with X-axis. Such curves were obtained by Miss Matthaei[10] in studying the carbon assimilation of cherry laurel at varying temperatures with unit light intensity. The problem is much more complicated, however, when variation of one factor is accompanied by changes in one or more other factors. This complication arises in plotting the temperature curve for enzyme activity. The curve rises at first according to van't Hoff's law of reactions, but eventually a maximum value is reached and the curve falls off. At some point near the end of the ascending portion of the curve a break occurs: for all temperatures below this point, temperature is the limiting factor and determines the activity of the enzyme; for all temperatures above this point, not temperature, but the amount of enzyme is the limiting factor. The higher temperatures cause a permanent inactivation or decomposition of the enzyme so that its activity is conditioned only secondarily by the temperature. There is also a time factor involved here; the longer the temperature acts, the more the enzyme is decomposed, within certain limits. The study

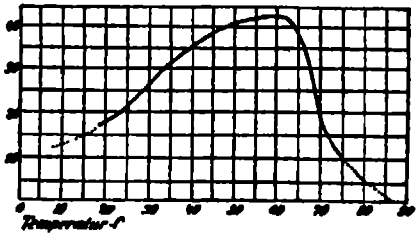

Fig. 2. Effect of temperature on the activity of malt diastase. (After Kjeldahl.)

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[8] *Cf.* the work of L. B. Mendel, T. B. Osborne and their pupils.

[9] *Cf.* B. E. Livingston, *loc. cit.*

[10] *Phil. Trans.*, B, 196: 47-105, 1904.

of the action of salt solutions on permeability, growth, etc., involve even greater complications produced by the interrelation of conditioning factors.

In order to get an accurate statement of the Law of Minimum, it is necessary to get away from the custom of discussing causes, however difficult this may be.[11] The idea of causation invariably indicates *incomplete analysis*. A biological phenomenon is dependent not on a single variable, but on a complex or constellation of factors, as we have seen in the case of carbon assimilation. It should be discussed therefore in terms of all the conditioning factors, not in terms of that one which temporarily happens to be a limiting factor. The term "function" is valuable in this connection. The amount of carbon assimilation is a function of the temperature; it is another function of the illumination, etc. With this idea of function in mind, the Law of the Minimum may be stated in the following form. *When a quantity is dependent on a number of variable factors and must be a function of one of them, the quantity is that function which gives the minimum value.* Expressed in plain English this means that a chain is no stronger than its weakest link. The Law of the Minimum is only too obvious. Its application is often so self-evident that it is made as a matter of course.

But the most interesting thing about the law is not how it works, but when it does not work. There is a fundamental discrepancy between the Law of the Minimum and Galton's Law of averages. In the current text-books on genetics and plant physiology[12] the following ingenious explanation of Galton's Law is given. Assume that the size of a bean is determined by only five variables, each of which must occur in one of two categories; in one case the size of the bean will be increased by one unit of size, in the other it will be decreased by the same amount. Considering all the possible permutations of these five variables, we get the following arrangement:

I	II	III	IV	V	Sum	I	II	III	IV	V	Sum
+	+	+	+	+	+5	+	+	−	−	−	−1
+	+	+	+	−	+3	+	−	+	−	−	−1
+	+	+	−	+	+3	+	−	−	+	−	−1
+	+	−	+	+	+3	+	−	−	−	+	−1
+	−	+	+	+	+3	−	+	+	−	−	−1
−	+	+	+	+	+3	−	+	−	+	−	−1
+	+	+	−	−	+1	−	+	−	−	+	−1
+	+	−	+	−	+1	−	−	+	+	−	−1
+	+	−	−	+	+1	−	−	+	−	+	−1
+	−	+	+	−	+1	−	−	−	+	+	−1
+	−	+	−	+	+1	+	−	−	−	−	−3
+	−	−	+	+	+1	−	+	−	−	−	−3
−	+	+	+	−	+1	−	−	+	−	−	−3
−	+	+	−	+	+1	−	−	−	+	−	−3
−	+	−	+	+	+1	−	−	−	−	+	−3
−	−	+	+	+	+1	−	−	−	−	−	−5

The beans will be of six sizes, + 5, + 3, + 1, — 1, — 3, — 5, and out of a very large number (n), $n/32$ will be + 5, $5n/32$ will be + 3, $10n/32$ will be + 1, $10n/32$ will be — 1, $5n/32$ will be — 3, and $n/32$ will be — 5. The six sizes are in the ratio 1:5:10:10:5:1. If we plot the sizes of the various classes of beans against the frequency of their occurrence, we get an approximation to the familiar curve of normal error. For the sake of simplicity, the number of variable factors was made five and the number of categories in which each might occur was limited to two. If the variables and the categories are made sufficiently numerous, the curve of normal error can be approximated within any desired degree of exactitude. It is unnecessary to point out the empirical fact that when the sizes, weights, etc., of organisms or their parts are divided into classes and the classes are plotted against the number of individuals in each class, the resulting curve approaches the normal curve of error, if a sufficiently large number of individuals are used. Exceptional instances of curves with more than one maximum, or only parts of curves, are easily accounted for and for convenience will be left out of consideration. Since the empirical data bear out the conclusions arrived at by the above procedure, the explanation may be considered valid.

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[11] *Cf.* B. E. Livingston, *loc. cit.*

[12] E. Baur, "Einführung in die experimentelle Vererbungslehre," 2te Auflage, 1914. L. Jost, "Vorlesungen über Pflanzenphysiologie," 3te Auflage, 1913.

However, the explanation involves the addition of the values of the various factors, which is in reality averaging them, since their value is measured in terms of net gain or loss. Although this process of averaging the various factors involved is borne out by comparing the results with empirical data, it is done, nevertheless, in contradiction to the Law of the Minimum. According to this law $n/32$ should be $+1$ and $31n/32$ should be -1, because *all* the factors are $+1$ in only one permutation, and -1 occurs in all the others and would be a limiting factor. The curve that would result if the Law of Minimum held would start from one at the upper end of the scale of sizes, weights or what not and would rise with great rapidity toward the lower end, where it would reach its maximum. This kind of curve is not the rule.

Every case where Galton's Law holds is a case where the Law of the Minimum does not hold. The resultant size or weight of an organism, which is a measure of its growth, shows that this is not determined by the limiting factor of its environment, but represents some sort of average between all the factors involved. In other words, a process of compensation or integration has taken place, the factors giving the largest values being utilized to some extent at least to alleviate the influence of the limiting factor—a utilization of surplus to cover deficit. Individual processes obey the Law of the Minimum; but the grand total is governed by what may be termed a principle of integration.

The means by which this integration is brought about are not hard to find. At least four important processes are at work in living organisms to this effect, namely—

1. Responses to stimuli,
2. Development,
3. Evolution,
4. Biotic succession.

A few examples will illustrate the way in which integration is effected by each of these. A seedling placed upside down is in the wrong position with respect to the center of the earth, its source of light, and moisture. Position with respect to gravity may be considered to be the limiting factor here; but the germinating rootlet is positively geotropic and bends toward the earth; the young shoot is negatively geotropic and bends away from the earth. In this way these responses to the geotropic stimulus counteract the influence of the limiting factor. Roots behave similarly in response to moisture content of the soil; stems and leaves in response to light.

In plants it is hard to draw a line between simple responses to stimuli and morphogenic responses which involve permanent changes of form and structure. The difference between sun leaves and shade leaves is a familiar example of a morphogenic response. The shape, size and structure of the leaf here counteract the limiting factor light. Again, plants which are shaded by others so that they receive insufficient light usually become etiolated, that is, the stems and leaf-petioles in many cases increase in length until some portion of the plant is brought to a position where it receives adequate illumination. Here again the limiting factor is light, and the result of etiolation is to overcome its effect.

Evolution is likewise an integrating process. Its results are not accomplished in the individual, but in the race, and are called adaptations. Adaptations are means of avoiding the effects of limiting factors.

Another means of integration is seen in biotic succession. Here the integration extends over a considerable period of time and its benefits do not accrue to the individual or the race, but to succeeding generations and different species. The integrative effect in succession may be largely produced by the death and decay of an association resulting in the accumulation of humus. Thus both xerophytic and hydrophytic plants prepare the way for a mesophytic flora. The limiting factor here is water, which is too scarce in the one case and too abundant in the other. By the accumulation of humus, the properties of the soil are so altered that a more favorable water supply is offered to later generations, and in this way the effect of the limiting factor is counteracted.

All these processes which bring about integration between the relations of living organisms to the factors of the environment that determine their growth and activity are evidently based on a single fundamental principle, to which Professor L. J. Henderson has applied the appropriate misnomer teleology.[13] Wherever integration is found in the factors influencing the individual, the race or the association, it is possible to define a closed system. Such a system includes all the factors which can be integrated, that is, all the possible limiting factors for any given process. These systems may focus about a single cell, an organ, an organism or a group of organisms. They are inclusive. The life of a plant, for example, is determined by a complex of factors between which integration is found to occur. At the same time the functional activity of the root system is determined by another complex of integrated factors, and the functional activity of the leaves by still a different set. Since the life of the root system is dependent on the products of the activity of the leaves, these represent members of the complex which conditions the growth and function of the root system. Such internal factors as enter into the complex of factors centering about the life of a portion of an organism are likewise subject to integration. In this way the condition of the root system affects the leaves and the condition of the leaves affects the root system. Correlations are therefore manifestations of the principle of integration.

The organic world can be analyzed into systems of various orders, those of a higher order being inclusive of, or divisible into, systems of a lower order. These systems are invariably overcoming the effects of limiting factors. The limiting factor is the stimulus to which the system reacts. The reaction places the organism in a more efficient relation with its environment, but no matter how many reactions are carried out, there is always some limiting factor left, and so the organism is kept constantly busy. The end result is to approximate more or less closely some kind of average of all the resources at its disposal.

I think it might be possible to go even further and get a quantitative measure of the degree to which the process of integration has been carried, by considering the number of factors integrated and how close an approximation to the normal curve of error had been obtained. Such a quantitative measure would likewise be an index of the stage of evolution that an organism had reached.[14] At the very least, the Law of the Minimum or the principle of limiting factors offers a sound basis from which such intangible processes as behavior, correlations, evolution and ecological succession[16] can be viewed with a clear perspective, if it is not the only scientifically accurate point of view from which to attack such problems. HENRY D. HOOKER, JR.

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[13] The order of nature, 1917.

[14] Our criterion of "degeneracy" in a living organism is based essentially on a decrease in the number or range of factors between which integration is possible.

OSBORN BOTANICAL LABORATORY,
YALE UNIVERSITY

THE PECK TESTIMONIAL EXHIBIT OF MUSHROOM MODELS

It is peculiarly fitting at this time to describe rather briefly the exhibit of mushroom models, recently installed in the State Museum at Albany, N. Y., as a memorial to the life and service of the late Charles Horton Peck, state botanist of New York from 1867 to 1915, a period of forty-eight years, all except the last two years having been spent in active service.

The final installation of these remarkable mushroom models was completed only a few days prior to his death, which occurred on July 10, 1917. The models, fifty-seven in number and representing fifty-five species of edible and poisonous mushrooms, are the work of Mr. Henri Marchand, an artist and sculptor of rare ability. The models are made of wax from casts in the field and reproduce with perfect fidelity to nature, the form, coloring and habitat of each species.

Space need not be taken to enumerate the entire list of species represented by the models, but the variety of form and color may be suggested by the following species which are represented in the collection.

Poisonous:
  Amanita phalloides
  Amanita muscaria
  Clitocybe illudens
  Russula emetica
  Inocybe asterospora
Edible or Harmless:
  Amanita caesarea
  Tricholoma sejunctum
  Tricholoma personatum
  Russula cyanoxantha
  Lepiota procera
  Lepiota naucina
  Agaricus campester
  Agaricus arvensis
  Coprinus comatus
  Morchella deliciosa
  Gyromitra esculenta
  Russula virescens
  Strobilomyces strobilaceus
  Pleurotus ostreatus
  Fistulina hepatica
  Armillaria mellea
  Boletus cyanescens
  Polyporus sulphureus

The services of Dr. Peck in the field of mycology are surpassed by no other American student of fungi. His work, although not confined to the fleshy fungi, is best known from the hundreds of species which he has described in the fleshy and woody groups of fungi (Agaricaceæ, Boletaceæ, Polyporaceæ, Hydnaceæ and Clavariaceæ).

Without the advantages of European travel and study and frequently working without access to the older European literature upon fungi, his work stands out with conspicuous individuality. That he has apparently described in some cases, species already described by the older mycologists of Europe is no reflection upon his remarkable ability in the discernment of specific and generic characters of our native species.

His work will stand for all time as the foundation upon which later students of the fungi may build with safety a more elaborate morphological and systematic revision of the fleshy and woody groups of fungi.

Those friends, admirers and fellow botanists, who have contributed toward bringing into existence this testimonial exhibit of mushroom models may well feel that there is no more suitable memorial possible. There are few pages of modern literature dealing with the fleshy and woody fungi that do not reflect in some degree the individuality of Dr. Peck's work, and looking at these models in the State Museum, with their exquisite variety of form and color, one may imagine with what pleasure and appreciation they would be viewed by him whom they memorialize. H. D. HOUSE

STATE MUSEUM,
ALBANY, N. Y.

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[16] For an application of the principles enunciated in this paper to plant ecology see G. E. Nichols, *Plant World*, Sept., 1917.

SCIENTIFIC EVENTS

FARM COLONIES FOR TUBERCULOUS SOLDIERS

It is stated in the *British Medical Journal* that during the past year the National Association for the Prevention of Consumption has urged the formation of farm or garden colonies where discharged tuberculous soldiers, while regaining their health, may be trained in open-air occupations At the annual meeting of the association on July 16, Professor Sims Woodhead sketched his own idea of a model farm colony. It should consist of a large enough tract of land to allow variety in the forms of cultivation introduced. The aim was not only to provide the patient with suitable and congenial work, but also to give him an occupation which should serve him as a means of livelihood, and a part of the farm colony, therefore, should be laid out on a generous allotment system. The colony should serve as an educational center and show how much could be done to improve the conditions of farm workers and the hygiene of farm buildings. To that end every farm colony should be a microcosm in which the maintenance of health and the prevention of infection should be absolutely secured. He thought also that accommodation should be provided for advanced cases. As far as possible, the patients should do the whole work of the colony themselves, and even the overseers should be tuberculous patients who were coming to the end of their term. The patient should help to contribute to the cost by his own labor. The state must provide the land, and it might also contribute towards preparation of the land and erection of the general buildings. But the special buildings, particularly the hospital buildings, should be jointly provided by local taxation, Treasury loan, and voluntary subscription. As the patient got stronger a certain portion of his earnings should be set aside as a bonus for him when he made a new start in life. In the subsequent discussion Sir R. W. Philip suggested that there was some risk of opening the door of the farm colony too wide. If the colony was to be a dumping ground for all grades of tuberculosis, its purpose would be defeated. There must be a clear separation between early and presumably curable cases and dying cases; for the latter, of course, humane provision must be made, but not that of a farm colony. The class of cases to be taken were those which lasted a much longer time than the sanatorium could afford to keep them. Sir William Osler said that the essence of success in the treatment of the consumptive soldier was that he must remain a soldier—that is, he must be under control. Discipline was a very necessary factor in the life of a farm colony. Sir A. Griffith-Boscawen, M.P., parliamentary secretary to the Ministry of Pensions, said that his department had been faced with the difficulty that medical boards had generally assumed that when a man was discharged for tuberculosis the condition was not attributable to military service, and the result was that until lately the man had been turned adrift without pension or other provision. In France in such cases the benefit of the doubt was given to the man. The conditions of the service might at least have brought out the disease earlier than it would otherwise have manifested itself. The policy now was to assume in all cases that the disease was the result of military service unless the contrary was clearly proved.

RESEARCH WORK OF THE RED CROSS IN FRANCE

Announcement has been made by the Red Cross that its War Council has appropriated $100,000 for medical research work in France. This action follows a report from Major Murphy, Red Cross Commissioner to Europe, who cabled the following from Paris to the National Headquarters at Washington:

> An extraordinary opportunity presents itself here for medical research work. We have, serving with various American units, some of the ablest doctors and surgeons in the United States. Many of these men are already conducting courses of investigation which, if carried to successful conclusions, will result in the discovery of treatments and methods of operation which will be of great use not only in this war, but, possibly, for years afterwards. To carry on their work they need certain special laboratory equipment, suitable

buildings, and animals for experimental purposes. At present, equipment and personnel can not be obtained through ordinary government sources without delay, which makes this source of supply quite impracticable.

Cooperation with Major Murphy in his plans is pledged by Dr. George W. Crile, of Cleveland, who headed the first Red Cross unit to reach France; Dr. Lambert, Dr. J. A. Blake, Colonels Ireland and Bradley, of General Pershing's staff, and various American experts on the ground.

A group of specialists in infant welfare has been sent to France by the American Red Cross. At its head is Dr. William P. Lucas, professor of pediatrics in the University of California.

He reports that there is need for doctors and nurses for work with mothers and children, and the Infant Welfare Unit will be prepared to give such immediate relief as it can. With him in the unit, which was financed by Mrs. William Lowell Putnam, of Boston, are Dr. J. Morris Slemons, of the Yale Medical School; Dr. Julius Parker Sedgwick, physiological chemist, professor at the University of Minnesota; Dr. John C. Baldwin, specialist in diseases of children; Dr. Clain F. Gelston, Dr. Lucas's assistant at the University of California; Dr. N. O. Pearce, another specialist, and the following experts in sociology and child-welfare work: Mrs. J. Morris Slemons, Mrs. William P. Lucas, Miss Elizabeth Ashe and Miss Rosamond Gilder, daughter of the poet. These specialists will survey the situation and study the work already being done by the French, and will practice without receiving compensation from patients. The task before the Red Cross, which will be carried on by this and succeeding units, is not only to cooperate with French specialists, but also to carry on a general educational campaign among French mothers in the interest of better prenatal hygiene and scientific feeding and care of the babies. Special efforts will be made to protect children from tubercular infection, which is particularly threatening France to-day as a result of trench warfare.

WAR DEMONSTRATION HOSPITAL OF THE ROCKEFELLER INSTITUTE

As has been noted in SCIENCE the Rockefeller Institute for Medical Research has recently opened a War Demonstration Hospital, on the grounds of the Institute, at Avenue A and 64th Street, New York, the funds for this purpose having been provided by a special appropriation of the foundation.

The purposes of this hospital are to treat patients suffering from infected wounds by methods which have been developed in European army hospitals, especially the methods developed by Dr. Alexis Carrel and Dr. H. D. Dakin, in the Military Hospital at Compiègne, France, and to demonstrate these methods in a practical way to American surgeons. The hospital will make no charge for treatment or care.

As a contribution to assist in solving the problem of cantonment, hospital and other temporary construction, the institute has housed the demonstration hospital in a series of portable buildings such as are used in the most improved base hospitals on the western front. In this way the conditions under which hospital work is carried on in France are imitated; at the same time there is demonstrated a method of knock-down construction which is used to a large extent at the front.

The War Demonstration Hospital is a double-walled construction with a double roof. It is thus well protected against both heat and cold; it is heated by steam, experience having demonstrated the desirability of steam in laundries, kitchens and wards, where more than 300 beds are installed.

The plan of the temporary hospital at the Rockefeller Institute was made by Mr. Charles Butler, a New York architect, who has for a year and a half studied French and British hospital construction in France; he collaborated with the French war department in designing hospitals.

On the basis of this experiment, it is probable that such hospitals could be erected and equipped in almost any part of the country at the rate of $700 a bed for a 500-bed installation.

Dr. Carrel has been granted leave of absence by the French government to come to New York to give personal supervision of the work of the temporary hospital. He is assisted in his work by Dr. Adrian V. S. Lambert, of the College of Physicians and Surgeons.

The war demonstration hospital has been organized with the approval and active cooperation of the war and navy departments. In admitting surgeons to follow the demonstrations and cases that are treated, preference will be given to members of the army and navy medical corps.

THE MATHEMATICAL ASSOCIATION OF AMERICA

The second summer meeting of the association will be held by invitation of Western Reserve University and Case School of Applied Science at Cleveland, Ohio, in conjunction with the summer meeting of the American Mathematical Society, beginning with a joint dinner at 6:30 o'clock Wednesday evening, September 5, and a joint session at nine o'clock Thursday morning, September 6, and continuing Thursday and Friday. The meeting of the American Mathematical Society begins Tuesday morning, September 4. The meetings will be held in the lecture room of the Physics Building of Case School of Applied Science.

The program committee consists of C. S. Slichter, Chairman; L. S. Hulburt, and E. J. Wilczynski. The program is as follows:

THURSDAY, 9:00 A.M.

Joint session of the Mathematical Association of America with the American Mathematical Society. Address by Professor L. P. Eisenhart, of Princeton University—"Darboux's contribution to geometry."

10:30 A.M.

"Undergraduate mathematical clubs"—Professor H. E. Hawkes, Columbia University. Discussion, led by Professor R. C. Archibald, Brown University, and Professor D. A. Rothrock, Indiana University.

2:00 P.M.

Presidential Retiring Address: "The significance of mathematics"—Professor E. R. Hedrick, University of Missouri. "Geometry for juniors and seniors"—Professor E. B. Stouffer, University of Kansas. Discussion, led by Professor Arnold Emch, University of Illinois, and Professor L. W. Dowling, University of Wisconsin.

FRIDAY, 9:30 A.M.

"The treatment of the applications in college courses in mathematics"—Professor L. C. Plant, Michigan Agricultural College. Discussion, led by Professor W. B. Carver, Cornell University, Professor G. H. Ling, University of Saskatchewan.

The committee on arrangements consists of T. M. Focke, Chairman; F. N. Cole, W. D. Cairns, E. V. Huntington, A. D. Pitcher, and D. T. Wilson. Members and visitors are requested to register as early as possible; this will be a distinct aid in helping those in attendance to become acquainted with one another and thus further one of the chief aims of the meetings. Registration will be held in the library of the Physics Building of Case School of Applied Science. It is hoped that, as at the meeting last year in Cambridge, members may wish to bring their wives to share in this sojourn in Cleveland and in the social hours which always accompany the meetings.

Hotel Statler has been selected as the official headquarters for the summer meetings of the American Mathematical Society and the Mathematical Association of America. Luncheon will be served each day, to those attending the meetings, at the Case Club. This building will be at the disposal of members and their friends for the afternoons and evenings during the meetings. The joint dinner of the Association with the American Mathematical Society will be held at the Hotel Statler, Wednesday evening, September 5.

W. D. CAIRNS,
Secretary-Treasurer

OBERLIN, OHIO,
August 18, 1917

JOHN OREN REED AND KARL EUGEN GUTHE

TABLETS to the memory of John Oren Reed and Karl Eugen Guthe were unveiled in the physics building of the University of Michigan at commencement. Following a short address by Professor Harrison McA. Randall, of the Department of Physics, they were accepted in behalf of the university by Regent J. E. Beal. The tablets were the gifts of former students and colleagues and were inscribed as follows:

THIS TABLET IS ERECTED BY
FRIENDS AND FORMER STUDENTS OF
JOHN OREN REED
1856–1916
PROFESSOR OF PHYSICS AND DEAN OF THE
DEPARTMENT OF LITERATURE, SCIENCE AND
THE ARTS, IN MEMORY OF HIS TWENTY-FOUR
YEARS OF FAITHFUL SERVICE AS A TEACHER
AND IN GRATITUDE FOR THE INSPIRATION GIVEN
THEM BY HIS STAUNCHNESS OF CHARACTER
AND BY HIS UNSWERVING DEVOTION
TO TRUTH AND TO PROGRESS.
MDCCCCXVII

TO

KARL EUGEN GUTHE, PH.D.,
BORN MARCH 5, 1866.
DIED SEPTEMBER 10, 1915.
AN EMINENT PHYSICIST, A BELOVED TEACHER,
PROFESSOR OF PHYSICS AND DEAN OF THE
GRADUATE SCHOOL OF THIS UNIVERSITY
THIS TABLET IS ERECTED BY
HIS STUDENTS AND COLLEAGUES
IN AFFECTIONATE REMEMBRANCE
MDCCCCXVII

SCIENTIFIC NOTES AND NEWS

Adolf von Baeyer, professor of chemistry at Munich, distinguished for his work on synthetic indigo and in other directions, has died at the age of eighty-two years.

The death is also announced of Eduard Buchner, professor of chemistry at Würzburg, who died from wounds while serving as major at the front. Dr. Buchner was distinguished for his work on the chemistry of fermentation, and was the recipient of the Nobel prize for chemistry in 1907.

Dr. G. Müller has been appointed director of the astrophysical observatory at Potsdam, in succession to the late Professor K. Schwarzschild.

The Paris Academy of Sciences has elected the following eight members as a committee on scientific research: MM. A. Laveran, from the section of medicine and surgery; Th. Schloesing, from the section of rural economy; Edm. Perrier, from the section of anatomy and zoology; J. L. Guignard, from the section of botany, and MM. G. Lipmann, E. Picard, A. Gautier, A. Lacroix, from the academy at large.

The Paris Academy of Sciences has awarded prizes in mechanics and mathematics as follows: The Bordin prize of 3,000 frs. has been awarded to M. Gaston Julia, now lieutenant in the army; the Francoeur prize of 1,000 frs. to M. Henri Villat, lecturer at Montpellier for his publications on hydrodynamics; the Montyon prize of 700 frs. to M. René de Saussure, docent at Geneva, for his work in mechanics; the Poncelet prize of 200 frs. to M. Jules Andrade, professor at Besançon, for his work in applied mechanics, especially chronometry.

Dr. Henry J. Waters, Manhattan, Kans.; Leon S. Merrill, Orono, Me.; Dr. Edwin F. Ladd, Fargo, N. D.; and David R. Coker, Hartsville, S. C., have been appointed state food administrators by the federal government.

Floyd R. Harrison, connected with the Department of Agriculture since 1906 in various capacities, has been appointed an assistant to the Secretary of Agriculture during the present emergency.

Mr. F. F. Longley, a member of the firm of sanitary engineers of Hazen and Whipple, has been made a major and sent to France to assume complete charge of the water supply for the American forces.

Dr Hugo Diemer, professor of industrial engineering in the Pennsylvania State College, has accepted a commission as major in the Ordnance Section of the Officers' Reserve Corps.

The American Red Cross has appropriated $800,000 to meet sanitary emergencies in the civilian areas surrounding army cantonments. A bureau under the direction of Dr. W. H. Frost, of the Public Health Service, will have charge of the work. The Red Cross will undertake such sanitary management only by request of the local organization in charge.

Dr. Victor G. Heiser, director of the Department of the East of the International

Health Board of the Rockefeller Foundation, is a member of the commission of the Red Cross which is making a survey of conditions in Italy, preliminary to a possible appropriation for relief by the Red Cross. Dr. Heiser has also consented, if the matter is undertaken, to head the work of establishing Red Cross relief stations in seaports having military significance for the United States and its Allies.

Professor Walter T. Fishleigh, of the University of Michigan, has been commissioned as major, to act as automobile engineer to the U. S. Medical Corps in charge of the engineering, testing, inspection, maintenance and repairs of all American ambulances in the army, both in this country and abroad. Professor Felix W. Pawlowski, also of the University of Michigan, is in the government service as aeronautical engineer in the signal corps with headquarters at the War Department at Washington.

Dr. Edgar T. Wherry, for the past four years assistant curator of the division of mineralogy and petrology of the U. S. National Museum, has been transferred to the position of crystallographer in the Bureau of Chemistry of the U. S. Department of Agriculture.

Dr. L. E. Dickson, professor of mathematics in the University of California, has accepted an invitation to be a visiting professor at the University of California for the first half of the coming academic year. He will return to the University of Chicago on December 20.

Dr. E. O. Hovey, curator of geology in the American Museum of Natural History, has reached home safely after an absence of over two years with the Crocker relief expedition.

Dr. A. W. Gilbert, professor of plant breeding at Cornell University, who has been on leave of absence for graduate work in rural economics at Harvard University, has resigned to accept an appointment with the Boston Chamber of Commerce. Donald K. Tressler, assistant in agricultural chemistry at the university, has also resigned to accept a position with the Bureau of Soils of the U. S. Department of Agriculture.

Dr. Mark Francis, of the Agricultural and Mechanical College of Texas, recently secured the vertebræ of some dinosaurs from the vicinity of Riesel near Waco. He has added these to the collection of Texas vertebrate fossils which he has been accumulating for some years and which includes the type specimens of *Equus Francisi*, named by Dr. O. P. Hay, of the National Museum, from material found near Eagle Lake, Texas.

The surgeon-general's office desires the names, addresses and ages of men in each class of every reputable medical school who have been drawn and accepted for military service under the provisions of the selective draft, these names to be vouched for by the deans of the respective medical colleges.

The board of health of Akron, Ohio, is seeking a health officer to take charge of the board of health, the salary of the position being $3,500.

The National Bureau of Standards has not yet obtained all the men needed to fill metallurgical positions with salaries varying from $1,200 to $2,000, depending upon the training and experience of the candidate. Men are desired with experience either in ferrous or nonferrous metallurgy. The duties in such positions will be almost entirely of an investigational nature, in connection with problems of military importance. Qualified men are urged to communicate to the Bureau of Standards at once a statement of training and experience, names of references, and minimum salary which would be accepted, so that they may be advised of appropriate civil service examination for which to file papers. Until further notice such papers are received by the Civil Service Commission at any time and rated promptly.

The Experiment Station Record states that as a result of experiments conducted by the department of chemistry of the South Dakota Agricultural College during the past twenty years, it is expected that sugar-beet factories will soon be established in both the eastern and the western part of the state. Information from western South Dakota, where sugar beets are being raised on a large scale, shows that the price of land has greatly increased. The loss of so many sugar factories in Belgium and France is reported as stimulating efforts to produce more sugar in this country.

UNIVERSITY AND EDUCATIONAL NEWS

DR. HENRY FREEMAN WALKER has bequeathed $100,000 to Middlebury College, to provide full salary for a professor on Sabbatical leave, any balance is to be used as an emergency fund for members of the faculty.

THE *Experiment Station Record* states that provision has been made by the Texas legislature for establishing a third junior agricultural college, to be known as the Northeast Texas Agricultural College. An appropriation of $250,000 has been made for its establishment and maintenance. The board of directors of the State Agricultural and Mechanical College is given control over the institution. State appropriations have also been made for the station and substations aggregating $225,095 for the year beginning September 1, and $181,270 for the following year.

A CHAIR of aviation has been founded in the London University by M. Basel Zaharoff, who before the war had established similar professorships in the universities of Paris and of Petrograd.

ROSS AIKEN GORTNER, Ph.D. (Columbia), associate professor of agricultural biochemistry in the University of Minnesota, has been appointed professor and head of the division of agricultural biochemistry in the university and chief of the division of agricultural biochemistry in the Minnesota Agricultural Experiment Station, succeeding R. W. Thatcher who becomes dean and director of the department of agriculture in the same institution. R. Adams Dutcher, assistant professor of agricultural chemistry in the Oregon Agricultural College, and Clarence A. Morrow, professor and head of the department of chemistry in Nebraska Wesleyan University, have been appointed assistant professors of agricultural biochemistry in the University of Minnesota. Clyde H. Bailey, cereal technologist and assistant professor of agricultural chemistry in the University of Minnesota, who for the past year has been on leave of absence and has been employed as chemist for the Minnesota State Board of Grain Appeals, Minneapolis, has resumed his duties in the university and has been promoted to an associate professorship in the division of agricultural biochemistry.

C. W. HOWARD, associate professor of entomology and parasitology of the University of Minnesota, has accepted the position of professor of biology in Canton Christian College, Canton, China. Professor Howard will sail from San Francisco the middle of October, visiting Hawaiian Islands, Manila and Japan *en route*. Canton Christian College is the only institution of collegiate rank in South China. The rapid growth of the agricultural and medical departments has made necessary the organization of a department of biology.

DR. L. B. AREY has been promoted from instructor to associate professor of anatomy in the Northwestern University Medical School.

DR. RAYMOND FREAS has been appointed adjunct professor of chemistry in the University of Virginia.

DR. J. ARCE has been appointed to a newly established chair of tropical pathology in the University of Lima, Peru.

DISCUSSION AND CORRESPONDENCE

THE INTERPRETATION OF THE RESULTS OF FIELD EXPERIMENTS WITH DIFFERENT PHOSPHATES

THE interpretation of results of field experiments with different phosphates is of present interest, especially as the conclusions reached by several investigators are being challenged by Dr. C. G. Hopkins, of the Illinois Agricultural Experiment Station.[1] As is well known, Dr. Hopkins has for several years been the ardent champion of raw rock phosphate as a fertilizer. He has been largely dependent, however, on data secured by others. In fact, not until very recently had he published results of his own experiments in which different phosphates were compared.

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[1] Hopkins, C. G., "Phosphates and Honesty," Ill. Agri. Exp. Sta., Circular 186.

Statements[2] recently made by him in regard to the conclusions drawn in Bulletin 90 of the Tennessee Agricultural Experiment Station even go so far as to impugn the ability of an author who would draw the conclusion that bone meal proved to be, in those experiments, superior to rock phosphate. In view of the detailed data contained in Bulletin 90, the writer is surprised that there should be any serious differences of opinion in the matter. Careful consideration has convinced him that Dr. Hopkins has laid unwarranted stress on a single table (XIII.), which gives some averages from the three longest-continued experiments, and that he has failed to give due weight to the results of the individual series. This raises a question as to the value of such a table, especially to the casual reader, for it is evident that if a short number of series be averaged a preponderance of a single series may distort or mask the true findings. Such a table, therefore, is open to criticism, and evidently should be used with discretion, but is justified as one way of presenting a summary.

Table XIII. of Bulletin 90 gives as stated, a summary from three series of experiments each conducted on a different type of soil. Series 1, as is pointed out on pages 69 and 70 and again on page 87 of the bulletin, was conducted on a soil which proved to be naturally too well supplied with phosphoric acid to be at all well adapted to the comparison desired, so much so that rock phosphate in the last four years of the five-year period proved unprofitable in three of the eight experimental conditions. Excessive growth with lodging reduced the yields of wheat on one half the bone-meal plots, and even acid phosphate was used with only a narrow margin of profit. The soils of the other two series proved, however, to be poor in phosphoric acid and hence well suited to a comparison of phosphates.

In series 2 the evidence is unsatisfactory because of the lack of agreement between the results of the two rock phosphate plots, one of which shows a slight loss and the other a good profit from the use of rock phosphate. If the latter be compared with the near-by bone-meal plots the rock phosphate shows more profit. In series 3, which was conducted on a soil especially poor in phosphoric acid, the evidence is decidedly in favor of bone meal as compared with rock phosphate. Under every one of the four experimental conditions of this series bone meal made a large increase in yield—equal, in fact, to the best obtained from acid phosphate and averaged 5.6 bu. of wheat per acre more than that obtained from rock phosphate. Even when calculated on the dollar-investment basis used by Dr. Hopkins, the average acre profit from $1.00 invested in bone meal was $3.05 as compared with $2.79 for rock phosphate. In this connection it should be mentioned that a comparison between bone meal and rock phosphate where the cowpeas were removed for hay was omitted in Table XIII. because only in series 3 was such a comparison made, the results being especially favorable to bone meal.

Series 4, which was not included in Table XIII., is also worthy of consideration. This series was conducted on a greatly impoverished type of soil, well known to be naturally poor in phosphoric acid. As measured by the yields of wheat, acid phosphate proved highly profitable, but both bone meal and rock phosphate were used at a loss. However, the writer's records and observations of these experiments, during the two years of their continuance, convinced him that bone meal could be used profitably in the reclamation of land of this character. On the other hand, rock phosphate appeared next to worthless. By way of confirmation, bone meal plots 9 and 11 produced in the second year an average of 1.41 ton of cowpea hay to an acre. The near-by rock phosphate plots 7 and 8 produced only 0.80 ton. The value of the difference between the two yields of hay would pay for the bone meal used and leave a good profit. The hay data were not given in Bulletin 90, but serve as a good illustration of the advantage in the interpretation of results that rests with the person conducting the experiments.

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[2] SCIENCE, November 3, 1916, p. 652.

In drawing his conclusions with regard to the showing made by the different phosphates, the writer was governed chiefly by a consideration of the soil conditions and results of the individual series and, as he thinks, very naturally placed acid phosphate first, bone meal second, and rock phosphate third in profitableness.

With all the individual series in view, let us see the kind of formula Dr. Hopkins must use in order to arrive at his conclusion with regard to the relative standing made by bone meal and rock phosphate. The formula and his conclusions may be stated as follows:

Disregard series 4, omit one half the bone-meal data of series 3, include series 1 (conducted on a soil not poor in phosphate), and with the acid of series 2 obtain averages which show that, as used, the bone meal returned more profit than the rock phosphate. Now, make the unwarranted assumption that the profit from bone meal would decrease in direct proportion to the quantity used, and obtain the result that a dollar invested in rock phosphate made a profit of 39 cents more than a dollar invested in bone meal, or, the rock phosphate was superior to the bone meal. Q. E. D.

In Science, March 2, 1917, page 214, Dr. Hopkins says: "The calculated profits mentioned in Professor Mooers's Science article[3] are evidently based upon different valuations than those reported in the bulletin." The writer finds that the calculated profits for both acid phosphate and rock phosphate, as given in the Science article referred to, should be divided by 2. This, of course, does not affect the relative standing of the two materials. One dollar invested in acid phosphate shows an average profit of $2.14 per acre where the cowpea crops were turned under, and of $2.71 where removed, but one dollar invested in rock phosphate gave an average return of only $1.29 under either condition. The writer has assumed that Dr. Hopkins could give a simple explanation for his conflicting estimates, as given in Science, November 3, 1916, p. 652, and in Science, March 2, 1917, p. 214. In the former article he says, "For each dollar invested rock phosphate paid back $2.29," but in the latter article he says, with regard to the same data, "Easy computations show profits per $1.00 invested of . . . $1.29 from phosphate rock."

From correspondence with dealers in rock phosphate, the writer is informed that until about six years ago the usual guarantee of fineness for the rock phosphate sold to farmers for fertilizer purposes was that 90 per cent. would pass through a 60-mesh sieve, but that the present guarantee is for 90 per cent. to pass through a 100-mesh sieve. Dr. Hopkins seems to have this in mind when he says, "Raw rock phosphate is now procurable in very much better mechanical condition than when these experiments were conducted."[4] That he was in error with regard to the rock phosphate used in the experiments referred to may be seen by reference to page 59 of Bulletin 90, where the following statement is made: "90 per cent. was found to pass through a 100-mesh sieve."

In conclusion, the writer will add, that on page 60 of Bulletin 90, the content of total phosphoric acid in the rock phosphate was stated to be 33.9 per cent. The usual guarantee and expectancy for this material, as sold to farmers for fertilizer purposes, is a little under 30 per cent. With perfect fairness the calculations for phosphate rock used in the experiments might have been placed on the latter basis, and an increase of 13 per cent. can be properly allowed—as was referred to on page 59 of the bulletin—to the estimated cost of the applications made. This change would appreciably increase the unfavorable showing made by the phosphate rock.

C. A. Mooers

Agricultural Experiment Station,
University of Tennessee

A METHOD FOR OBTAINING AMŒBA

In common with many teachers I have found it necessary, at the opening of college in the fall, to provide large numbers of the indispensable amœba. I venture to set down a method which I have found successful during several years. Publication of other methods for obtaining a large and more or less continuous supply of these animals has not been infrequent and many are familiar with use of *Elodea* (*Philotria*, Michx.-Britton), *Ceratophyllum* and other aquatic plants.

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[3] Science, January 5, 1917, pp. 18 and 19.

[4] Science, March 2, 1917, p. 214.

The ditch-moss is not readily found in many localities. My personal experience with several aquatic plants yielded indifferent results and failed to give sufficient numbers until, by chance one season, I tried the marsh plant, *Elodes campanulata* (*Triadenum virginicum* (L.) Raf., see Britton and Brown) and was rewarded with large numbers of amœbæ. Although absence from town in some seasons occasioned a too long interval between the times of collection and the use of the material, or made it impossible to provide the proper sequence of cultures, I have seldom been disappointed in finding the animals, though they may not have come just when wanted.

The usual custom was followed in making up the cultures. Crystallizing dishes or battery jars—the shallower dishes gave the better results—were crowded not too densely with the stems of the plants. The stems were usually cut two or three times. Tap water and water from the pond or marsh where the plants were collected were used, separately, but no difference in results was noted. The dishes were covered with plates of window glass, placed in a room of moderate temperature and there allowed to remain in diffuse light for a period of three weeks or more. When pains were taken to collect the plants at intervals and provide a sequence of cultures the results were most gratifying.

I have used the plant from four different localities, collecting from the water and from banks where the plants could only have been submerged at high water and mixing, with success in all cases. Since the locality seems not to be a controlling factor, and since the cultures of tap as well as pond water yield the animals, I assume that the *Elodes* is favorable for the original lodgment of amœbæ and their later multiplication.

O. E. Gordon

Amherst, Mass.

CROSSING-OVER IN THE SEX CHROMOSOME OF THE MALE FOWL

Several years ago an experiment was begun with the object of studying the inheritance of several sex-linked characters associated in the same individual, but the experiment had to be laid aside until last year. The second generation chicks are now at hand and prove beyond doubt that crossing-over takes place between the sex chromosomes of the male fowl.

In this preliminary report attention will be confined to the factors themselves, without regard to the somatic appearances of the individuals. Three dominant sex-linked characters, viz., B, I, and S were employed. B and I were introduced on one side; S, on the other. Hence the F_1 males were all BI, S,; B and I being in paternal (or maternal) sex chromosome, S in the maternal (or paternal). These males have been tested by mating them back to females of the composition b Is, b is.

If there were no crossing-over, offspring of this back cross showing the combination of somatic characters found in the F_1 male, would not occur. Actually, however, they do occur, thus demonstrating that crossing-over has occurred, a chromosome having the composition B I S, having been formed. Other cross-over classes have appeared, but the one cited is the one at the present age of the chicks, most easily recognized.

No crossing in the female is to be expected on theoretical grounds. None was observed in the original cross. Partly because of practical reasons and partly because no new combinations were available in F_1, it seemed wise to defer a test of this point until next season, when the new combination B I S should be available in the mature female.

H. D. Goodale

Massachusetts Agricultural
Experiment Station

THE EQUAL PARALLAX CURVE FOR FRONTAL AND LATERAL VISION

In the article by Mr. C. C. Trowbridge on "The importance of lateral vision in its relation to orientation"[1] is given an equal parallax curve showing the distances that a man and a bird must move forward to give the same apparent displacement of objects against the horizon. It is the purpose of the following note to derive an analytic expression for this curve.

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[1] Science, N. S., Vol. XLIV., No. 1135, pp. 470–474, September 29, 1916.

Consider first the case of lateral vision. Let A be the starting point of the bird, and let the two objects, A_1 and A_2 in the original axis of vision be at the distances a_1 and a_2, respectively, from A. Let y be the distance that the bird moves forward, and α the angle that is subtended at its eye by the distance A_1A_2. (See Fig. 1.) Then

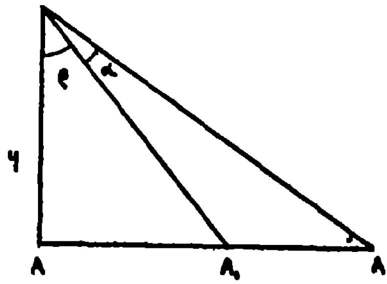

FIG. 1.

$$(1)\qquad \tan(\alpha+\beta)=\frac{a_2}{y},\quad \tan\beta=\frac{a_1}{y},$$

where β is defined in the figure. Using the trigonometric formula for the tangent of the sum of two angles, and replacing $\tan\beta$ by its value from the second equation of (1), we get

$$(2)\qquad \frac{y\tan\alpha+a_1}{y-a_1\tan\alpha}=\frac{a_2}{y}.$$

Solving this for y gives

$$(3)\quad 2y\tan\alpha=a_2-a_1\pm\sqrt{(a_2-a_1)^2-4a_1a_2\tan^2\alpha}.$$

In taking up the case of frontal vision, it is necessary, as Mr. Trowbridge states, to have a deflection between the line connecting the observed objects and the direction of the man's motion. Designating the angle of deflection by δ, and the distance that the man moves from A by x (see Fig. 2), we have by the law of sines

$$(4)\qquad \frac{x}{a_1}=\frac{\sin(\gamma+\delta)}{\sin\gamma}=\cos\delta+\cot\gamma\sin\delta,$$

where again $AA_1=a_1$, $AA_2=a_2$, and α is the angle subtended at the eye of the observer by A_1A_2. The angle γ is defined in the figure. Also

$$(5)\qquad \frac{x}{a_2}=\frac{\sin(\alpha+\gamma+\delta)}{\sin(\alpha+\gamma)}.$$

By using the value of $\cot\gamma$ obtained from (4), we can easily eliminate γ and reduce (5) to

$$(6)\qquad \frac{x}{a_2}=\frac{x\sin(\alpha+\delta)-a_1\sin\alpha}{x\sin\alpha-a_1\sin(\alpha-\delta)}.$$

Solving for x gives

$$(7)\qquad 2x\tan\alpha=a\pm\sqrt{a^2-4a_1a_2\tan^2\alpha},$$

where

$$a=(a_2+a_1)\cos\delta\tan\alpha+(a_2-a_1)\sin\delta.$$

Equations (3) and (7) then are parametric equations of the equal parallax curve.

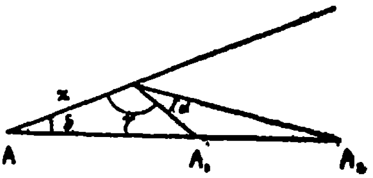

FIG 2.

In plotting the curve of the practical problem we assign the values $x=0$, $y=0$ for $\alpha=0$. To a value of α slightly greater than zero will correspond two values of x from (7) and two values of y from (3). It is easily seen that for the practical problem the smaller of these must be chosen in each case; that is, we must use the negative sign before the radicals in (3) and (7). For Mr. Trowbridge's curve the special values $a_1=1{,}000$, $a_2=2{,}000$ must be assigned, and in all instances δ must of course be known.

PAUL R. RIDER

WASHINGTON UNIVERSITY,
ST. LOUIS, MO.

A PREDECESSOR OF PRIESTLEY

TO THE EDITOR OF SCIENCE: The notice of the Priestley Memorial in the issue of SCIENCE for August 17, 1917, reminds me of the best chemical joke I have ever heard. I can hardly forgive the "new chemistry" for having spoiled it. At our Brown University club dinners in Philadelphia we never have any wine. Many years ago when water was "HO" the late Rev. Dr. H. Lincoln Wayland, the best wit I ever have known, after a very happy eulogy of water, ended his after-dinner speech in the following manner: "Our chemists tell us, forsooth, that the composition of water was unknown until Priestley discovered oxygen in 1774. Never was there a greater mistake, for did not the prophet cry out, ages ago, 'HO! Everyone that thirsteth.'" W. W. KEEN

PHILADELPHIA, PA.,
August 20

SCIENTIFIC BOOKS

The Physical Basis of Society. By CARL KELSEY, Professor of Sociology in the University of Pennsylvania. New York. D. Appleton & Co. 1916. Pp. xvi + 406.

As its name indicates, this book deals chiefly with the physical basis of human society. The following subjects are considered in sequence: the earth and man, mutual aid and the struggle for existence, the control of nature, the evolution of man, heredity, heredity and society, race differences, sex differences, the influences of society upon population, social institutions, and the nature of progress.

In the chapter on the earth and man, the author introduces too much detail for an elementary sociological work, especially on pages 1 to 28. Moreover, the real social significance of much of the material is not clearly shown. It would have been much better if the author had developed such a topic as the size and customs of the social group as influenced by the prevailing method of food getting, which is conditioned by physical environment.[1] Pages 28 and following give a fairly satisfactory summary of geographic influences.

In the chapter on mutual aid and the struggle for existence, the author again loses himself in a mass of ill-digested detail about the chemical and bacteriological aspects of plant life, and devotes to this subject space out of all proportion to its sociological significance.

The chapter on the control of nature is done more successfully, but the chapter on the evolution of man is very unsatisfactory. In this latter chapter the author launches into a discussion of the old controversy about the evolution of man. He has reduced statements and quotations from authorities to such small compass that their real meaning and spirit are largely lost. At present, when students are generally open-minded in regard to the doctrine of evolution, it is a waste of time to revive this theological controversy in a book that is non-historical. The real subject-matter of this chapter, if the title is any indication of its aim, is treated in a few scant pages at the end.

The chapter on heredity is superior to any of the preceding and is a good treatment of the subject. The clarity of presentation might have been improved by better selection of diagrams. The chart on page 236 illustrating the inheritance of polydactylism, although taken from such a reliable source as Guyer, is not well selected to illustrate the inheritance of a dominant trait. An analysis of this chart reveals the fact that the transmission of polydactylism as a Mendelian trait in the family shown, is explicable only on the assumption that it is a recessive—and this contradicts the caption. But explanation of the chart in terms of the sex-limited hypothesis does, however, permit its interpretation in terms of dominance. Yet the author has not introduced this qualification, hence the example is not satisfactory. The remaining chapters are superior to the earlier ones.

In general, the book gives all appearances of having been too hastily written, and thus furnishes grounds for the criticism that the work of sociologists is superficial. This is all the more deplorable because the general plan and logic of arrangement of the book are excellent. F. STUART CHAPIN

SMITH COLLEGE,
NORTHAMPTON, MASS.

Recreations in Mathematics. By H. E. LICKS. New York, D. Van Nostrand Co. 1917. Pp. v. + 155, $1.25.

This is an amusing little book with various problems of more or less interest, particularly to the teacher of elementary mathematics. Unfortunately the historical notes are largely incorrect. In addition to mathematical problems and random notes on elementary mathematics through the calculus there are similar notes on astronomy and the calendar, and on mechanics and physics.

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[1] See Ellen Semple's "Influence of Geographic Environment," pp. 54 to 65.

Louis C. Karpinski

SPECIAL ARTICLES

THE EFFECTS OF THYROID REMOVAL UPON THE DEVELOPMENT OF THE GONADS IN THE LARVÆ OF RANA PIPIENS

In a paper published in Science, November 24, 1916, a general account was given of my experiments performed in the spring of 1916 upon the removal of the anlagen of the anterior lobe of the hypophysis and of the thyroid gland in early tadpoles of *Rana pipiens*. It was shown that in each case this operation prevented metamorphosis. A full account of the results of the removal of the anterior lobe of the hypophysis has been published.[1]

Now the effect of thyroid removal upon the development of the gonads has been largely worked out. A full account of this latter phase of the work will be published in due time, together with papers by students of mine who have worked along correlated lines. It seems desirable in the meantime to give a brief account of the most interesting theoretical results of my investigations.

It was shown in my earlier paper that in the absence of the thyroid gland the tadpoles failed to undergo metamorphosis. Development went on normally up to the time when the hind limbs reached a length of 4–5 mm. At this stage the limbs entirely ceased to develop while the body as a whole failed to undergo further differentiation. While the tadpoles increased very greatly in size they at no time showed any further evidences of metamorphosis. This was true in spite of the fact that they eventually attained a length of body—exclusive of tail—varying from 30 to 43 mm. These figures are far in excess of any length normally attained by tadpoles of this species. From time to time specimens were killed and studied. At the date of writing, March 20, two of these tadpoles still remain alive and are in the same stage of bodily differentiation that they had reached the last of June.

This not only involves leg length, the failure of the tail to decrease in length and the failure of the mouth to change in form, but it involves the retention by the intestine of the original relative length characteristic of tadpoles. The lateral line organs became more highly developed than ever. In short a strictly larval form is maintained for months.

Now it is true that failure to metamorphose may likewise be attained by insufficient feeding if brought about at a sufficiently early stage of development. One larval tadpole with hind legs 5.5 mm. in length was kept in its larval condition by feeding very meagerly to November 15. At that time an effort was made to cause it to increase in size and to attain metamorphosis. Although it ate food it remained quite small, not showing any marked increase in size, nor did it show any strong tendency toward metamorphosis. When killed Febaruary 22 the testes were found to be quite small, they showed spermatogonia but no tendencies toward spermatogenesis. This was in strong contrast to the condition in a thyroidless tadpole with a body length of 43 mm. killed February 7. In this tadpole the testes were well developed, spermatogenesis was most active and thousands of completely formed spermatozoa were found in the testes, although the tadpole had remained in a strictly larval form with hind limbs only 5.5 mm. long and with a stomach and intestine length of 426 mm.—over 12 times the length of the corresponding organs in normal frogs at the time of metamorphosis.

The above cases are compared in order to show that although starvation may serve as one means of retarding metamorphosis, it also retards the development of the gonads and of the contained germ cells. This has been thoroughly established in an unpublished paper by Mr. Wilbur Swingle, one of my graduate students who carried out a series of experiments upon this same species. This case is cited to obviate the objection that the conditions here set forth might have been produced by starvation and not in thyroidless tadpoles properly fed. The continued development of their gonads and germ cells, and the normal metamorphosis of the similarly fed controls all show conclusively that we are here dealing with conditions resulting from the removal of the thyroid glands.

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[1] *Biological Bulletin*, March, 1917.

It must be kept in mind that the thyroid anlagen were removed at their very inception. It is fair to say that in these tadpoles there has never at any time been any thyroid secretion. A careful study of serial sections has demonstrated with certainty the total absence of these glands in the crucial cases used as a basis for this work.

The germ glands of the thyroidless tadpoles develop quite normally throughout, both as to structure and rate of development. When the operated tadpoles begin to lag behind the controls in general bodily differentiation, the gonads have already undergone sexual differentiation but have not yet shown any tendencies toward spermatogenesis. The remarkable feature of these experiments is seen in the fact that although differentiation of the soma halts completely at this early stage, the gonads continue to develop normally, keeping pace at every stage with the development of the gonads in control specimens. This applies both to the development of the gonads as a whole and to the development of sperm and ova.

At the time of metamorphosis the testes of both controls and thyroidless specimens showed similar dimensions. In no cases were there evidences of spermatogenesis. A thyroidless tadpole killed September 14 showed very active stages of spermatogenesis terminating in the production of many spermatids; but as yet no spermatozoa. Ripe spermatozoa were, however, found in a thyroidless tadpole killed December 15. In this case they were few in number, but in a thyroidless tadpole killed February 7, to which reference was made above, they were very numerous. This latter specimen had testes nearly twice as large as those of young frogs at the time of metamorphosis and of course very far beyond the condition found in tadpoles of a similar stage of body differentiation.

No less striking were the conditions in female specimens. At the time of metamorphosis, the central cavity of the ovary had formed, but the organ had not yet become folded as was later to be the case. All but a few scattered germ cells had become converted into large oocytes. An average of 12 of the largest measured showed dimensions of .2025 mm. × .2502 mm. As time passed, the thyroidless tadpoles showed continued growth of the ovaries. On February 14 they reached a size twice as great as at the time of metamorphosis. During all this time the oocytes of the thyroidless tadpoles steadily increased in size, as seen in specimens killed from time to time. In a thyroidless tadpole killed February 14 the average dimensions of the oocytes were .4027 mm. × .5207 mm. It is quite interesting to compare with this the conditions found in a normal young frog that metamorphosed last summer, living in the open and reaching a length of 48 mm. When it was killed March 13 the larger ova were seen to have reached an average size a trifle below that of the case just given, namely, .4123 mm. × .4540 mm., although the ovaries as a whole were somewhat larger, 8.05 mm. × 99.2 mm. as compared with 6.6 mm. × 7.2 mm. in the thyroidless tadpole killed March 15. This is probably due to the difference in bodily nutrition and is about proportional to the length of body of the two specimens compared.

From all this evidence I feel that we are justified in stating that the absence of the thyroid gland does not affect the development of the gonads or germ cells up to the time of sexual maturity in the male nor does it hinder the development of the ovary and ova, at least up to the period when the ova are visible with the naked eye. It is, of course, possible that the astonishing modifications of the soma may later secondarily affect the nutrition of the developing ova, but this is beyond the point.

These results are in line with some unpublished work by Mr. Wilbur W. Swingle, who at my suggestion studied the effects of thyroid feeding upon the germ glands and germ cells of *Rana pipiens* tadpoles. He shows that while this brought about the well-known result of hastening metamorphosis with all of the attendant modifications, as had been known from the work of Gudernatsch, it did not in any wise modify the rate of development of the germ glands and germ cells.

The most striking result of all is the evidence brought forth to show that germ cells and soma are different in their nature, that the germ cells are unaffected by the thyroid, while the soma is so profoundly influenced by it. It is possible that further work may show that there are other structures that continue their development unhindered in the absence of the thyroid gland, but the work thus far has failed to demonstrate them.

This investigation throws light upon the problem of neoteny. We can with perfect justice say that we are here dealing with a case of artificially produced neoteny in a form which does not show it in nature. Here we can point to a very specific cause for this phenomenon, about which there has been so much conflicting speculation.

Bennet M. Allen
University of Kansas

THE STANSIPHON

Amongst the many interesting and useful pieces of apparatus shown in the scientific exhibit during the Christmas meetings of the American Association for the Advancement of Science was a self-starting siphon, the trade name for which is the Stansiphon.

For the information of those members of the society who did not see the model shown at that time and in the general interest of science, I am giving a brief description of its construction and operation followed by a statement of some of its more practical applications as well as inherent limitations as at present constructed.

The self-starting device is shown in Fig. 1 and consists of a bulb (4) sealed into the lower end of the tube (2) and an inner tube (5) sealed into the base of the bulb and reaching into the opening of the bulb at the top. Here the end is somewhat constricted and its size and position with respect to the top of the bulb is so adjusted that an "air trap" is produced at (6). A small opening (7) is made at the lower part of the bulb.

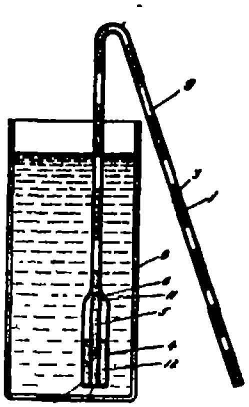

Fig. 1.

If the bulb be inserted to a considerable depth into the liquid to be siphoned, the liquid flows into the bulb through (7) and displaces the air which with the water passing through the inner tube (5) rises in a broken column in tube (2) and flows out through the delivery tube.

The height to which the given liquid may be raised will depend on the size of the bulb, the depth to which it is immersed, the construction of the "air trap," the material of which the siphon is made, the rate at which the bulb is inserted, etc. To operate successfully on ordinary liquids the Stansiphon should be immersed to a depth at least two or three times the length of the bulb.

Preliminary experiments were made by the inventor on water and the present design has greatly increased the efficiency of the siphon, both as to height lifted, and the rate of flow. A design of larger size has been made which successfully siphons acids from carboys, but owing to the heavy density of these acids it works relatively slowly as compared with water. Light oils such as kerosene and gasoline are readily siphoned by this method, but as yet a suitable design depending on this principle has not been found for the heavier oils.

The wide application of the Stansiphon is apparent especially in chemical laboratories, drug stores, manufacturing and other establishments where liquids and various solutions are in constant use. In transferring corrosive poisons or valuable liquids it obviates liability to accident or waste. It should also have a wide application in the filling and emptying of all sizes of storage-battery jars. It is at present being used for siphoning beer from kegs and wine from barrels. When a solution is to be kept "on tap" for instant use a stopcock may be provided. These siphons in addition to glass are being made of brass, copper, zinc, lead, iron, hard rubber, etc.

When the self-starting attachment is sealed to a straight tube ending in a capillary, a very efficient intermittent Hero's Fountain is obtained, as shown in Fig. 2.

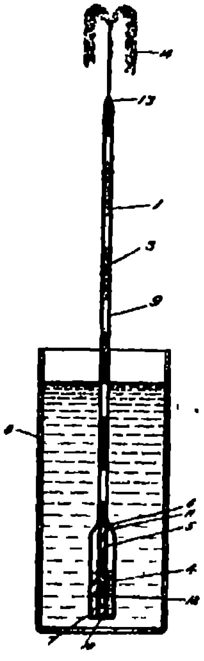

Fig. 2.

Application for patent rights has been made in the name of the inventor, Gustavus A. Storm, but all rights, title and interest in the same has been assigned to the Standard Scientific Company of New York.

P. B. Perkins

Brown University

THE AMERICAN PHILOSOPHICAL SOCIETY

At the annual general meeting of the society held in Philadelphia from April 13 to 15, the address of welcome was made by the President, Dr. W. W Keen, who, with Vice-presidents W. B. Scott, George E. Hale and Albert A. Michelson, presided. This meeting is a notable event among scholars and over forty papers were presented in the sciences and in the humanities. The national crisis also received some attention, Dr. M. T. Bogert, of Columbia University, outlining the work chemists may do to aid the National Research Council in the solution of certain war problems. Proper insignia to identify "members of the industrial army" so they may not be called slackers was urged. Attention was called to England's sad mistake in permitting general enlistment for "the front" when in many cases men with special ability could have been of so much more value using their brains in the laboratory. A well-trained industrial army is just as important as the army of fighters. The program with a number of abstracts follows.

April 12

William W. Keen, M.D, LL.D, President, in the chair

The trial of animals—a little known chapter of medieval jurisprudence: Hampton L. Carson, LL.D., Philadelphia.

Medieval sermon-books and stories and their study since 1883: Thomas Frederick Crane, Ph.D., Litt D., professor emeritus of the Romance languages and literature, Cornell University.

Some recent acquisitions to the Yale collection: Albert T. Clay, LL.D, professor of Assyriology and Babylonian literature, Yale University.

Vision as a physical process: Herbert E. Ives, Philadelphia. (Introduced by Dr. A. W. Goodspeed.)

The diagnostic method of training intelligence: an education for the fortunate few: Lightner Witmer, Ph.D., director of the Laboratory of Psychology, University of Pennsylvania.

Historical notes on "the armament of Igor": J. Dyneley Prince, Ph.D., professor of Slavonic languages, Columbia University.

A new translation of the Hebrew Bible: Cyrus Adler, Ph.D., president of Dropsie College for Hebrew and Cognate Learning, Philadelphia.

APRIL 18

George Ellery Hale, Ph.D., Sc.D., LL.D., F.R.S., Vice-president, in the chair

Lighting in its relation to the eye: Clarence E. Ferree, Ph.D., professor of psychology, Bryn Mawr College. (Introduced by Dr. W. W. Keen.)

The work of which this paper is a brief outline was done under the auspices of the American Medical Association's subcommittee on the hygiene of the eye, of which Dr. William Campbell Posey, of this city, is chairman. The object of the work has been to compare the effect of different lighting conditions on the eye and to find the factors in a given lighting situation which cause the eye to lose in efficiency and to experience discomfort. In all, forty-two different lighting situations have been investigated, selected with special reference to the problem in hand. Also a number of miscellaneous experiments have been conducted pertaining to the hygienic employment of the eye. Tests were made to determine the eye's aggregate loss in functional activity and to analyze this effect. In all seven different types of tests were used.

Factors influencing the sex ratio in the domestic fowl: Raymond Pearl, Ph.D., biologist, Maine Agricultural Experiment Station, Orono, Maine.

The problem of the sex ratio is one of the most important of biology from the theoretical standpoint as well as from that of the practical breeder or farmer. The desire to control the proportions of the sexes produced is one which has excited mankind through the ages. Thanks primarily to the work of certain American biologists, notably Professor C. E. McClung, of the University of Pennsylvania, and Professor E. B. Wilson, of Columbia University, the key to the riddle of sex has at last been found. It is well known that in a wide range of animals there is a definite hereditary mechanism which irrevocably determines the sex of the individual. While it is true that a definite mechanism controls the determination of sex, yet there has appeared a great deal of evidence recently, of varying degrees of trustworthiness, that sex ratios may be experimentally modified and controlled. It is the purpose of this paper to examine the sex production question in the common fowl, and see to what conclusions it leads. In the present war conditions any information which would make it possible for the poultryman or farmer to produce a larger number of pullets to lay eggs without producing so many cockerels to eat up costly food, would be of very great value. This study, which is based on eight years' experiments, and over 22,000 individuals, demonstrates first that the determination of sex in poultry is primarily a matter of a definite, hereditary mechanism, just as it is in insects and other forms which have been studied. At the same time, it is demonstrated that under certain physiological circumstances the operation of this mechanism may be modified in such a way as to lead to the production of more females, in proportion to the number of males. The chief factor in bringing about the modification in the direction of a larger production of females is the fecundity or laying ability of the hens used as breeders. The larger the number of eggs which a hen lays before being put into the breeding pen, the larger will be the proportion of females and the smaller the proportion of males produced by her eggs. Some years ago it was shown by the speaker that the ability to lay eggs (fecundity) in poultry is a matter of definite Mendelian inheritance. As a result of this knowledge, it is possible to breed strains of hens in which high productivity is a definitely fixed characteristic. The present results taken in connection with the earlier ones show that when the poultryman breeds along the right lines for increased egg production, he will at the same time be producing a strain in which profit making pullets preponderate in place of the less profitable cockerels.

Significant results of scientific investigations applied to fishery problems: Hugh M. Smith, M.D., LL.D., commissioner of fisheries, Washington, D. C. (Introduced by Dr. Clarence E. McClung.)

A description of a new photographic transit instrument: Frank Schlesinger, Ph.D., director of the Allegheny Observatory, University of Pittsburgh.

In many departments of astronomy it has been found that visual methods can advantageously be replaced by photographic. This experiment is an attempt to make a similar substitution in the case of the determination of star places. The experiment is a timely one, since astronomers are confronted with the necessity for observing the places of many stars, this necessity arising out of the recent striking developments in the matter of star-streaming.

Probable masses of comets: Henry Norris Russell, Ph.D., professor of astronomy, Princeton University.

The relationship of stellar motions to absolute magnitudes: Walter S. Adams, A.M., Sc.D., assistant director of Mt. Wilson Solar Observatory, Pasadena, Calif., and G. Strömberg.

The spectroscopic method of deriving the absolute magnitudes of stars and a new formula connecting parallax and proper motion have been utilized to study the relationship between the motions of stars and their true or absolute magnitudes. About one thousand stars have been used in the investigation. The results establish almost certainly a definite increase of velocity with decrease in brightness. In radial velocity this is of the order of 1.5 kilometers for each magnitude for stars of the F, G, K and M types of spectrum. This is to be interpreted, probably in part at least, as an effect of mass: that is, the smaller stars move more rapidly than the larger stars. This increase of velocity with decrease in brightness is found to persist among the groups of stars arranged according to their distance from the sun. Accordingly the evidence does not indicate that the nearer stars are moving more rapidly than the distant stars.

Nebulæ: V. M. Slipher, Ph.D., director of the Lowell Observatory, Flagstaff, Arizona. (Introduced by Professor C. L. Doolittle.)

Early man in America: Edwin Swift Balch, A.B., Philadelphia.

The present status of knowledge about early man in America may be summed up as follows. Early man was here. He lived during at least a part of the Pleistocene period for tens of thousands of years south of the glacial moraines He probably went through an Eolithic period and certainly through a Chelleen period in some places and therefore was truly a Paleolithic man. He may have made rudimentary fine art. Paleolithic American man was the ancestor of the Neolithic historic Indian and although less advanced in culture much like his descendant in anthropological characteristics. Whether he was an autochthone in America or whether he came from some other place and if so when, we do not as yet know positively, although his affiliations seem to be to the west. And it is to four men above all others that we owe our knowledge: Abbott, the discoverer of paleolithic implements and horizons; Volk, the corroborator; Lund, the first finder of probably Paleolithic bones, and Winchell, the investigator of patination.

The influence of the admixture of present immigrant races upon the more original stock: Charles B. Davenport, S.B., Ph.D., director, Station for Experiment Evolution, Cold Spring Harbor, Long Island.

A new Babylonian account of the creation of man: George A. Barton, Ph.D., LL.D., professor of biblical literature, Bryn Mawr College.

The waters of death: Paul Haupt, professor of Semitic philology, Johns Hopkins University.

April 13

Albert A. Michelson, Ph.D, Sc.D., LL.D., F.R.S., Vice-president, in the Chair

Crushing of crystals: Percy W. Bridgman, assistant professor of physics, Harvard University.

Hollow cylinders cut from single crystals have been subjected to unique tests by applying large hydrostatic pressures to the external surface. The crushing strength under these conditions is much higher than that found by ordinary tests, and the manner of failure is different. This has an interesting geological significance in suggesting that open cavities may persist in the earth's crust at greater depths than could be expected from the usual methods of measurement.

Structure of the spectra of the phosphorescent sulphides (describing measurements by Drs. H. E. Howe, H. L. Howes and Percy Hodge): Edward L. Nichols, Ph D, D.Sc., LL.D, professor of physics, Cornell University.

The Corbino effect in liquid mercury: Edwin Plimpton Adams, Ph.D., professor of physics, Princeton University.

Spontaneous generation of heat in recently hardened steel: Charles Francis Brush, Ph.D., Sc.D., LL.D., Cleveland.

I., Condensation and evaporation of metal films; II., The minimum potential for excitation of the "D" lines of sodium: Robert Williams Wood, A.B., LL.D., professor of experimental physics, Johns Hopkins University.

Growth and imbibition: D. T. MacDougal, Ph.D., LL.D., director of department of botanical research, Carnegie Institution of Washington, and H. A. Spoehr.

The mechanism of overgrowth in plants: Erwin F. Smith, B.S., Sc D., Bureau of Plant Industry, Department of Agriculture, Washington, D. C.

The behavior of self-sterile plants: Edward M. East, Ph.D, professor of experimental plant morphology, Harvard University.

There are really two problems connected with the inheritance of self-sterility in plants. One is the relation between self-sterile and self-fertile plants, the other is the behavior of self-sterile plants when crossed together. They should not be confused. The *Nicotiana* self-fertility is completely dominant over self-sterility. Either of the self-sterile species *Nicotiana alata* or *Nicotiana forgetiana* may be crossed with the self-fertile species *Nicotiana langsdorffii*. The result in each case is an F_1 generation that is completely self-fertile. The F_2 plants show the usual monohybrid ratio of 3 self-fertile to 1 self-sterile. Given the basic factor for self-sterility in the homozygous condition as in the case in *Nicotiana forgetiana* and *Nicotiana alata*, two plants may be either *cross-fertile* or *cross-sterile* with each other. Reciprocal crosses always give the same result. Thus the character behaves as if it were sporophytic rather than gametic. In other words, the constitution of the mother plants and not the constitution of the gametes which they produce determines whether a combination shall be fertile or sterile. This fact indicates very strongly that gametes have no other function than fusion with their complements, that the potential characters which they carry are wholly latent until the development of the zygote begins. The cross-sterility shown is of such a nature that if plant A is sterile with plants B and C, plant B must be sterile with plant C. Generalizing upon the basis of the behavior of self-sterile plants in intercrosses one may say that a self-sterile population consists of a small number of groups of plants each plant being cross-sterile with all plants belonging to the same group and cross-fertile with all plants of all other groups. These facts naturally lead to the conclusions that the behavior of self-sterile plants in inter-crosses is regulated by several transmissible factors all of which are distinct from the single basic factor for self-sterility and which presumably may be carried by self-sterile plants. A plant homozygous for self-sterility can neither be fertilized by its own gametes nor by the gametes of any other self-sterile plant of like constitution as regards these regulation factors, but any two plants differing in these regulatory factors are cross-fertile.

Twin hybrids from Œnothera lamarckiana and franciscana when crossed with Œnothera pycnocarpa: George F. Atkinson, head of the department of botany, Cornell University.

Œnothera lamarckiana × *Œ. pycnocarpa.* There is a splitting in the F_1 with production of twin hybrids. One of the twins (*pycnocarpa* type) has rosette leaves narrow and deeply cut over the basal half as in *Œ. pycnocarpa*, but the leaves are strongly crinkled as in *Œ. lamarckiana.* The other twin (*lamarckiana* type) has rosette leaves, narrow furrowed, not crinkled as in *Œ. pycnocarpa*, but with plain edge as in *Œ. lamarckiana.* The rosettes of the *pycnocarpa* type strongly resemble those of *Œ. pycnocarpa* because of narrowness and cutness, while at the same time they resemble *Œ. lamarckiana* in convexity and crinkledness. The general appearance of the rosettes of the *lamarckiana* type suggests neither parent, since the factors selected represent the less striking character of each. These two twin types are fixed in the first generation, since they are repeated in the F_2 and probably in the following generations in accord with the usual behavior of twin hybrids determined by de Vries. The progeny is remarkably uniform, in that respect following the feature of uniformity in the progeny of the parents, except for an occasional mutant from the *pycnocarpa* type. This mutation factor is probably inherited from *lamarckiana*. *Œnothera franciscana* × *Œ. pycnocarpa.* There is a splitting in the F_1 with production of twin hybrids. One of the twin hybrids (*pycnocarpa* type) has rosette leaves with the narrowness and cutness of *Œ. pycnocarpa*, but otherwise modified by *Œ. franciscana.* The other twin has rosettes very similar to those of *Œ. franciscana*, somewhat modified by *Œ. pycnocarpa*, and showing considerable fluctuating variations, parallel with those of *Œ. franciscana.* In the F_2 generation there is a one-sided splitting similar to that which occurs in the F_2 of twins from *Œ. hookeri* × *Œ. lamarckiana* described by de Vries. The *pycnocarpa* type twin has a hybrid constitution and in the F_1 splits into two types, the *pycnocarpa* type and the *franciscana* type, the latter presenting fluctuating variations parallel with those in the parent *franciscana.* The other twin (*franciscana* type) is fixed in the F_1 since it repeats itself in the F_2 and probably in the succeeding generations, but it presents the fluctuating variations characteristic of the parent *franciscana.* The *franciscana* twin probably carries the *pycnocarpa* factors also, but in a subordinate or permanently latent condition. If so, it is a physiological homozygote. If it is possible to introduce a splitting factor into the *franciscana* twin by an appropriate cross, and cause the *pycnocarpa* character to reappear in some of the progeny, the fundamental heterozygotic constitution of the *franciscana* twin would be demonstrated.

Arthur W. Goodspeed,
Secretary

(*To be continued*)

SCIENCE

FRIDAY, SEPTEMBER 7, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

PLANT ECOLOGY AND ITS RELATION TO AGRICULTURE[1]

I. CONTENT OF ECOLOGY

A. Nature and Scope.—In beginning this discussion, a brief statement as to the nature and scope of ecology seems to be desirable on account of the hazy popular notions on the subject. Outside of a rather narrow circle one usually finds a total ignorance of the meaning of the word itself, and even among biologists, some are familiar only with the observational side, due probably to the early prominence of the "car-window" school of ecologists, while others consider that the subject-matter of ecology might better be divided between morphology and physiology, and frankly state their opinion that there is no such subject as ecology.

However, there seems to be a mass of subject-matter belonging to neither department exclusively, but partly to each, which would fairly warrant the formation of another department. This has been named ecology, and may be defined as the science of organisms as affected by the factors of their environment. The connection with physiology is the closer of the two, and in fact, the two subjects overlap to a certain extent, but whether we call this overlapping segment ecological physiology or physiological ecology, the character of its subject-matter is sufficiently different to warrant a separate category and different treatment.

The methods of ecology have been, of course, largely descriptive, but they are also becoming increasingly quantitative, employing in many cases elaborate and delicate instruments. The work is pursued both in the field and in the laboratory, and under experimentally controlled conditions, as well as under natural. The great task of ecology and the purpose of its observation and experimentation lies in the interpretation of the phenomena and the deduction from these data of the general principles underlying the reaction of plants to their environmental factors.

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[1] Delivered before the Illinois Academy of Science, February 23, 1917.

B. Content of General Ecology. 1. *Autecology.*—This branch of ecology studies the plant as an individual, and is largely physiological in nature. It considers the general results of the relation of the plant to its environmental factors, as shown in the division of plants into great classes according to their reaction to each of the leading factors.

These reactions come under three heads: First, the reactions in the activity only of the plant, as the increase of activity under favorable conditions and its diminution and even stoppage under adverse conditions. This group really belongs under the head of physiology, but when considered in the field under natural conditions it may be regarded as within the scope of ecology. Second, the effects on plastic tissues or organs of the plant. These may also be produced experimentally and frequently have an important bearing on the economic value of cultures. Third, the effects on permanent structure and function of plant organs.

Whatever may be our belief as to the method by which variations are produced and fixed in plants, it is evident that structures correspond more or less to function and are conditioned directly or indirectly by the environment. A comparative study of plants in different habitats leads us to identify or construct from the imagination certain "normal" or original types of organs. We find also modifications of these types, which are either temporary, where the plant tissues are plastic; or permanent, constituting variations. In tracing the correspondence of these changes to environmental differences we look for and frequently think we find what may be called ecological causes.

Plants are classified according to these modifications, both plastic and permanent, on the basis of the factor which seems to be chiefly responsible for the change. Chief among these is the moisture relation, expressed in the more or less familiar division into hydrophytes or water lovers, xerophytes or dry-climate plants, and mesophytes inhabiting an intermediate habitat. A similar relation to light and temperature divides plants into sun-tolerant and shade-tolerant, heat-tolerant and cold-tolerant, groups. The relation to the chemical elements in the soil is not so marked as was once thought to be the case, yet we still hear such words as "calciphiles" and "calciphobes," and the terms probably represent to a certain extent a real situation. The best illustration of this is shown in a comparison of organs, especially leaves, of hydrophytic as compared with xerophytic and mesophytic plants. Here there seems to be a very distinct correspondence between structure and the markedly different environments of these different habitats.

2. *Synecology,* which studies plants in the mass, is largely concerned with distribution of plants, and may be regarded as an application of autecology in the grouping of plants within greater or smaller areas of the earth's surface. It may be divided into (*a*) "Phytogeography," in which the groupings are regional and the result of climatic factors, and (*b*) "Physiographic Ecology," in which the groupings are local, as the result of physiography with attendant climatic modifications. These groupings are called plant associations and the fact that different associations

follow each other successively is expressed in the term "Plant Succession."

C. Special Ecology of Structural Groups.—While all ecological groups have more or less specific reactions which are considered under their appropriate heads, there is one grouping which demands separate treatment because it is based on the most striking structural feature—the presence or absence of woody tissue, and also because of its practical relation to man's activities. Although verging more closely on agriculture, it may still be classed as ecology because the point of approach is from the side of the environmental relations. On the basis of woody structure we classify plants as trees and herbaceous plants with shrubs and lianas occupying an intermediate position, and it is at once evident that these two groups have decidedly different ecological reactions.

1. *Ecology of Trees and Shrubs.*—This study would involve (*a*) description of leading species with their habits of growth, characteristic structures, and ecological interpretation of the same. This would be the autecology of the group. (*b*) The synecology would involve the distribution and range of the leading species and their relation to ecological causes. (*c*) We might notice also the influence of the species on their environment as illustrated in the influence of forests on soil moisture content through their control of run-off; and the influence of individual trees, as for example, the eucalyptus in the reduction of soil water; also the influence of forests on soil in the formation of humus and the effect of trees on wind, as in protection by windbreaks. (*d*) It could include also a classification of trees according to the character of their wood, including distribution of the different woods and methods of utilizing. Also a similar classification according to the character of their fruits, their chemical products and their value for ornament.

2. *Ecology of Herbs.*—Here should be studied (*a*) the general characteristics of herbs as distinguishing them from trees, with the ecological differences involved, under the heads of shoot, root, flower and fruit, with the characteristic differences between perennials and annuals; (*b*) a study of herbs as classified according to their value to man, as: valueless or "wild," those of economic value or "cultivated," and those undesirable or injurious, which we call "weeds." Uncultivated herbs are of interest chiefly synecologically as the associates of trees in their different groupings and as indicators of the characteristics of the environment, as hydrophytic, xerophytic, etc. As the subject of taxonomy has to do chiefly with the wild herbs it is frequently included under ecology to-day.

Cultivated herbs and their attendant, though undesirable forms, are considered more from the autecological side. Their reactions to and tolerance of extremes of temperature and moisture and chemical conditions, are of course of chief importance. Original habitat and distribution and to some extent taxonomic relations, are also important as indicating suitability for certain environments. This value is testified to by the systematic search for new varieties carried on by the United States Department of Agriculture. Herbs vary greatly in their reactions to environmental factors, and should be grouped as far as possible along the lines of similar behavior. Knowledge of these groups should be as complete as possible, but a thorough study of the ecological reactions of a few type genera and species should be included in any comprehensive course in ecology.

3. The ecology of lower types of plants is not treated separately, but on account of

economic importance under the special subject of bacteriology, mycology, etc.

II. RELATION OF ECOLOGY TO AGRICULTURE

A. Purpose and Scope of Agriculture.—The subject of agriculture is extremely complex and even the terminology is not uniform in usage. Even the word agriculture itself is employed in a general and a special manner. It is used here in the general sense of the cultivation of plant products from the soil. Its complexity is made evident by consideration of the varied ends sought, which include size, strength, water content, and chemical contents of stem, leaves, roots, flowers, fruit and special parts such as fibers, cork, etc.

The resulting subdivisions of the subject following largely the usage of Bailey's "Cyclopedia of Horticulture," are: Agriculture (in its special sense), which includes the culture of grain, forage crops, bread stuffs, textiles, etc.; horticulture, which includes fruits, vegetables, flowers and ornamental plants, and forestry, which is the complete treatment of other trees, and includes subjects of sylviculture, mensuration and harvesting. Through all this complexity runs a general unity of purpose, namely, the preparing and maintaining of optimum conditions for the production of maximum returns. Therefore the processes and principles are in the main the same, being varied in practise for the different ends.

B. Agricultural Processes with their ecological significance.

1. The preparation of optimum conditions. The preparation of the soil is the first condition, but as the principles are the same as those in the preservation of optimum conditions it will be considered under that heading. The second important factor is the securing of suitable stock, either seed or vegetative, for which the criteria are the taxonomic relations and the reactions to the environment. The choosing of this stock is a question of balancing specific reactions of the desired plant with the factors of the necessary location, or vice versa. The securing of this stock is brought about either through breeding, by pollination, or by grafting; and by choice, through the testing of known varieties, the selecting of the results of breeding, or the discovery of new varieties. Of course through all these methods runs the question of reaction to the desired environment. A third ecological factor in preparation of conditions consists in the choice of a suitable time and location for the culture.

2. The preservation of optimum conditions. (*a*) The condition of first importance is the soil. In its moisture content the maintenance of optimum moisture conditions is of course extremely important. The maintenance of its physical condition is popularly called tillage. The chemical composition is shown by analysis and experiments with plants, and is modified by the use of fertilizers and of other chemicals. The temperature of the soil is less considered, but may be determined by the use of soil thermometers. (*b*) Optimum conditions of light, wind and temperature depend upon exposure, and may be controlled by modifications of this exposure. Light is studied by light intensity experiments and controlled by screening or by thinning. The effect of wind is shown largely by transpiration, measured by the atmometer, controlled by thinning or by windbreaks. Temperature is observed by the thermometer and controlled by shelters and by protective covering. (*c*) The importance of disease as a factor has been recognized by the great development of the subject of plant pathology.

3. The third agricultural process is the

harvesting of crops, in which ecology does not function very largely, except in so far as it may assist in the determining of the time of maximum returns.

C. Nature of Contributions of Ecology.—It is admitted by all, that agriculture is largely an art, and that its processes until rather recently were developed almost entirely by empirical methods. Evidences of this are still shown in many agricultural texts and farmers' bulletins, where processes are recommended because of success in certain localities or condemned because of failure.

As scientific knowledge and methods advanced, the agriculturists began to take advantage of these methods and we find many agricultural practises based on truly scientific work. This is especially true of the agricultural chemists from the days of Liebig down, although their claim to the title agriculturalists in the ordinary sense of the word might be questioned by some.

It must be recognized that many of the methods of agriculture are still empirical, and in some cases necessarily so on account of the lack of equipment of the constituency, but it is admitted that the scientific are better where possible. Even in experiment station work, there is a danger present, through the tendency to accumulate masses of data with too little correlation and generalization. The purpose of experimentation is to determine causes and to draw general principles whose application will avoid the necessity of further experiments. Failure to generalize nullifies this purpose; in fact, unlimited experimentation is empiricism.

The methods of ecology are scientific, its materials are largely the same as those of agriculture and its practical applications are found chiefly in the field of agriculture. For these reasons it is evident that ecology belongs both to botany and to agriculture, and in fact covers the debatable ground between the two subjects. Instead of this being, as is too often the case under such circumstances, the cause of rivalry and even conflict, it should furnish a common ground for cooperation and both parties should endeavor to maintain a high standard in investigation and generalization of the condition of plant responses to environmental factors.

The services of ecology to agriculture then are twofold, first in the developing of the principles on which agricultural practices are to be based, and second in furnishing a comprehensive source of information for the handling of specific cases and the answering of specific questions of agricultural policy.

D. Illustrations from Definite Contributions of Ecology.—Atmospheric moisture is observed quantitatively by means of the atmometer, which may be used as a measure of plant transpiration. Recent results show a most remarkable detailed correspondence between the curve of an open-pan atmometer and that of a controlled plant of alfalfa. In soil moisture content the mechanical determining of the wilting coefficient by the centrifugal method is a valuable achievement, and is having an increasing application in the determining of the quantity of water to be applied in irrigation. The study of the extension of root systems is having an increasing influence in determining the relation of plants to the soil moisture content.

In light we have both the measure of the intensity of light by Wiesner and Clements, and recently the measurement of photolytic ability of light by a delicate apparatus devised by MacDougal. Under chemical content the recent work of Coville with blueberries is widely known on account of its publication in the *National Geographic Magazine.* One of the difficulties of this quantitative work lies in the fact that the factors all work together on the plant, and measurement taken of individual factors may not indicate the true effect of the same factor working with others. Livingston's suggestion of using the living plant as an index is aimed at overcoming this difficulty.

Along physiographic lines, Cowles's recent work on so-called lakes of the Mississippi valley has applied the principles of plant succession in a very practical way. The control of moving sand is best accomplished by application of ecological principles in the choice of plants for that extremely xerophytic habitat.

E. Place of Ecology in an Agricultural Course of Study.—Up to the present the method in agricultural texts and courses has been to teach a little plant morphology, a chapter on plant activities, and then nine tenths of the work on agricultural practise. In addition to that we would recommend the insertion of a section on ecological principles, covering the content of ecology as outlined above. This should be general and theoretical, yet so related to agricultural practise as to form a suitable foundation for an agricultural course. A knowledge of these principles is fundamental to any real grasp of the subject.

In conclusion, emphasis should be laid on the fact that this discussion does not aim to criticize present agricultural activities, but to emphasize what is now being done along scientific lines for the development of the general principles underlying the practise of agriculture, and the importance of its extension as far as possible. Secondly, to point out the opportunities in this growing branch of science and to urge the teaching of some brief but comprehensive study of the principles of ecology in all agricultural courses.

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FISH NAMES, ANCIENT AND MODERN, AND EARLY ILLUSTRATIONS OF FISHES

A favorite topic which has engaged the attention of naturalists in all ages has been the identification of the names bestowed on plants and animals by ancient authors, particularly those of classical antiquity.

Probably no living naturalist has made more profound study of this subject than Professor D'Arcy Wentworth Thompson, of Dundee. whose "Glossary of Greek Birds" (1895) and new translation of Aristotle's "History of Animals" (1910) are monuments of patient industry and vast erudition, both philological and zoological. So able a critic as the late Dr. T. N. Gill has recorded[1] in glowing terms his appreciation of the merits of Professor Thompson's researches.

Dr Gill's own labors in the same field have illumined many an obscure point in the interpretation of ancient Greek and Roman writers on natural history. We may recall here an article of his in the *American Naturalist* for 1873 (vol. 7, pp. 458–463) "On the Status of Aristotle in Systematic Zoology"; also his address before the American Association in 1896 on "Some Questions on Nomenclature." His scientific papers and reviews fairly teem with discussions of fish etymologies, and his article on the Glanis of Aristotle is a fine presentation of the results of scholarly research.[2]

Dr. D. S. Jordan also, to mention only one other contemporary ichthyologist, has performed, in association with H. A. Hoffmann, a valuable service in investigating vernacular names, ancient and modern, as applied to the fishes of the Greek peninsula and archipelago. A joint paper by Jordan and Hoffmann, embodying a catalogue of the fishes of Greece, was published in the *Proceedings of the American Philosophical Society* for 1892.

Among ichthyologists of the last century, Georges Cuvier was probably at more pains than any other author to determine what species of fish were referred to under the appellations of early writers. After him A. Koraes (or Coray), Johannes Müller, Louis Agassiz, Erhard, Lowe, and the various editors and translators of Aristotle (Strack, Barthélemy, J. G. Meyer, Ogle, Aubert and Wimmer) and other ancient writers also rendered notable services. Other commentaries of value relating to the Greek fauna and its nomenclature were made during the last century by President Felton and Professor Sophocles of Harvard, and by several native Greek students, such as Nicolaos Christo Apostolides, D. Bikélas and Ioannos Bouros. The last-named was a professor at Athens, and published an essay in Greek of which an abstract appeared in Oken's Isis for 1841. Apostolides is author of a catalogue of the fishes of Greece and also of a list of the freshwater fishes of Thessaly.

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[1] Science, Vol. 33, 1911, pp. 730–738.

[2] Bull. George Washington Univ., Vol. 5, 1906.

Johannes Müller, in his elaborate memoir[3] "Ueber den glatten Hai des Aristotelis," devotes a separate section to the attempts of 16th century ichthyologists to identify the species of shark (*Galeus lævis*) referred to by the "father of natural history."

In point of fact nearly all of the 16th to 18th century writers on fishes—Belon, Rondelet, Salviani, Gesner, Willoughby, Aldrovandi, Artedi, Linnæus, Bloch and Schneider, together with lesser lights, and not forgetting Charles Estienne[4]—filled their works with copious references to and annotations on the numerous observations on fishes that have come down from classical antiquity. Among these "fathers of modern ichthyology" Aldrovandi is credited by Sundevall, in his introduction to the "Thierarten des Aristoteles," with having "fast alles gesammelt, was die Alten über die Thiere gesagt haben." But with respect to Aristotelian writings alone we cannot do better than quote Professor Thompson's remark, that "to annotate, illustrate, and criticize Aristotle's knowledge of natural history is a task without end."

It will thus be seen that there has been a steady succession of commentators upon the etymology of ancient fish names from the beginning of the modern science of ichthyology down to the present day; nor are commentaries wanting upon early patristic and mediæval authors who have left memorials of the knowledge of the times respecting natural history topics. Thus, there was published a score of years ago, by Hosius, an annotated edition of Decius Magnus Ausonius, a Roman consul of the 4th century whose idyll on the Moselle contains recognizable descriptions of sixteen species of fish. Modern editions have been published[5] also of Konrad von Megenberg's "Buch der Natur," written about the middle of the 14th century, a work which in itself is but a free rendering in the German vernacular of "De Natura Rerum," by Thomas of Cantimpre (b. 1201, d. 1272). A similar service has been performed by H. Stadler for the "Historia Animalium" of Albertus Magnus (b. 1193, d. 1280). As an illustration of Konrad's style of description the following extract may be quoted from his chapter on Fishes. It relates to the Remora or Echeneis:

> Echeneis haizt ain ech. Der visch ist halpfuesig, sam Jacobus und Isidorus sprechent, und ist sô kreftig, daz er ain schef stil helt, daz ez sich nindert wegt, ez slahen die wind in daz mer oder ez slahen die ünden, und wie sêr die wazzerflüzz diezzen, sô mag daz schef weder für sich noch hinder sich, reht als ob ez dâ gruntvest hab und dâ gewurzelt sei, niht dar umb, daz ez daz vischel wider ziehe, neur dar umb, daz daz vischel dar an hanget. Daz sprechent auch Ambrosius, Jacobus [*sic*] Aquinas, Aristotelis, Isidorus und der groz Basilius. Nu spricht Albertus . . . Plinius, Rabannus, Alex-

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[3] *Abhandl. Akad. Wiss. Berlin*, 1840 (1842), pp. 187–258.

[4] Charles Estienne (Lat. Stephanus, b. 1504, d. 1564), a physician at Paris, was author of "La maison rustique," which passed through thirty editions. In 1537, and again in 1544 and 1546, he published a commentary on classical names of plants and animals entitled as follows: De Latinis et Græcis nominibus arborum, fruticum, herbarum, piscium et avium liber; ex Aristotele, Theophrasto, Dioscoride, Galeno, Nicandro, Athenæo, Oppiano, Æliano, Plinio, Hermolao Barbaro et Johanne Ruellio, cum gallica eorum nominum appellatione. Lutetiæ, 1544. 84 p. 8°.

[5] One by F. Pfeiffer in 1861, and another by H. Schulz in 1897.

ander, Solinus, Jeronymus, Augustinus, Adelinus, Haimo, Ambrosius, Maister Jorach."[6]

Although Konrad von Megenberg's "Buch der Natur" has been properly recognized as the earliest natural history compendium in the German language, we must go back two centuries earlier before meeting the first German naturalist. This distinction belongs to the remarkable personage known as Saint Hildegard (in Latin Hildegarde de Pinguia, b. 1098, d. 1179), abbess of Bingen. Her original observations on natural history are contained in nine books called the "Physica," the first printed edition of which appeared in 1533, and the second in 1536. Book V. of this work, in 37 chapters, treats of fishes, and the descriptions of them are given in such terms that all of the species are identifiable.[7]

Concerning mediæval fish names it will be sufficient to refer to but two or three other publications, all by German philologists. One is an essay of 35 pages by Friedrich Schmidt, entitled "Die mittelenglische Version des Elucidarius des Honorius Augustodunensis," published in 1909. Another is J. J. Koehler's work of 87 pages devoted exclusively to old English fish names, published as Heft 21 of Anglistische Forschungen, Heidelberg, 1906. Lastly, mention should be made of Professor Karl Krumbacher's publication of "Das mittelgriechisches Fischbuch," a Byzantine work dating from about the twelfth century.

Returning to our own times, a long list might be given of articles dealing with the vernacular names of fishes in nearly all modern languages, including Chinese and Japanese. We will, however, content ourselves with citing but two useful works, the first of which contains a bibliography of 31 pages. These are, first, Émile Belloc, "Noms scientifiques et vulgaires des principaux poissons, etc.," Paris, 1899, 200 p. 8°. And second, P. P. C. Hoek, "Catalogue des poissons du Nord de l'Europe avec les noms vulgaires dont on se sert dans les langues de cette region" (Conseil Perm. Int. Explor. Mer, Pub. de Circonstance, no. 12, 1904).

EARLY PORTRAYALS OF FISHES

A special bibliography would be required to enumerate all of the articles that have been written on such subjects as prehistoric effigies of fishes, their representation in Egyptian monuments, ancient Greek vase paintings, Pompeian frescoes, the catacombs of Rome, and in the plastic and textile arts of pre-Columbian inhabitants of the western world. There is even a special group of articles dealing with the fish as a religious symbol in the early church, and with the fish motive in Christian art. But in the present note we wish to consider a more modern phase of fish portrayals.

Fishes and "sea-monsters" figured frequently in popular mediæval legends and bestiaries, and grotesque drawings of them were taken over into printed books from manuscript works which had been in circulation prior to the invention of printing. Among the various Herbals, or household recipe-books for medicines, which contained accounts of animals as well as plants and their uses in medicine, one that passed through numerous editions and translations was the "Hortus Sanitatis" of an author or compiler who styles himself Johannes von Cube. This soubriquet has been supposed by some to be a punning pseudonym for Dr. Johann Wonnecken, town physician of Frank-fort. The "Hortus," or "Ortus," was first issued at Metz about 1475, and other editions appeared at Strasburg about 1590 and later. The part entitled "Tractatus de piscibus" is divided into many short chapters, and has numerous woodcuts of fish and fishing, all of very singular character.

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[6] Concerning the last-named authority, "Jorach" or Jorath, little is known except that he was an eastern, perhaps Persian writer, whose work "De Animalibus" is quoted by the thirteenth century encyclopedists, Vincent de Beauvais, Albertus Magnus and Bartholomæus Anglicus. Bartholomew's encyclopedia, "On the Properties of Things," was written originally in Latin some years prior to 1260, and was translated into English by John Trevisa in 1397. An epitome of it, under the title of "Mediæval Lore," was published by Robert Steele in 1893.

[7] See in particular L. Geisenheyner, "Ueber die Physica der heiligen Hildegard von Bingen, etc." *Sitzber. Naturh. Ver. Preussen, Rheinlande u. Westfalens,* 1911 (1912), *E,* pp. 49–72. Also E. Wasmann, Hildegard von Bingen als älteste deutsche Naturforscherin. *Biol. Centralbl.,* Vol. 33, 1913, pp. 278–288.

Those who are familiar with ancient angling literature will recall in this connection the earliest known book on fowling and fishing, written in Flemish and printed at Antwerp in 1492. It is usually referred to as the "Boecxken," or in German as "Buechlin" or "Fischbuchlin" (editions of 1552 and 1578), and contains woodcuts of angling scenes. As a treatise on fishing, this tract has priority in date over "The Book of St. Albans," ascribed to Dame Juliana Barnes, Bernes or Berners. The first edition of this work was printed by the school-master printer of St. Albans in 1486, but did not contain the "Treatyse of fysshynge wyth an angle" with its accompanying woodcut. The second edition, from the press of Wynkyn de Worde at Westminster in 1496, does contain it, however, and it appears also to have been published as a "lytyll plaunflet" in London about 1500. There are excellent modern facsimile editions of both the "Book of St. Albans" (M. G. Watkins, 1880) and the early Flemish tract known as "Boecxken" (Alfred Denison, 1872). A still earlier facsimile edition of Dame Barnes' book is that by Mr. Joseph Haslewood, in 1810; and in 1816 the same bibliographer brought out the second English edition of "The Dialogues of Creatures Moralysed." The edition was limited to 100 copies, and of these 56 were destroyed by fire. A Dutch version was printed in 1480, and a French in 1482, both of them containing illustrations of fish and fishing scenes.

Modern reproductions have also been published of the remarkably fine animal drawings in the "Album de Villard de Honnecourt" (Lassus, 1858), dating from the thirteenth century in France, and in "Das Tierbuch des Petrus Candidus, geschrieben 1460" (Killermann, 1914). It is to be hoped that before very long we may have at our disposal facsimile reprints of the wonderful animal figures, including fishes, which embellish four valuable codices preserved in the Landesbibliothek at Stuttgart. Two of these manuscripts happen to be translations of the "Liber de Natura Rerum," by Thomas of Cantimpré, who spent fifteen years in its preparation prior to 1240. Strangely enough, although translations of this work have been published (one of them by Konrad von Megenberg, noticed above), the original text has never been printed. Large portions of it were, however, incorporated by Vincent de Beauvais in his various works, especially his the "Speculum Naturale." Besides the Stuttgart codex of Thomas Cantipratensis, others are preserved in the libraries of Paris and Cracow. In Book VII., the author treats of freshwater and marine fishes.

For the benefit of those interested in the history of early prints and book illustrations we may refer finally to the recently published "List of works in the New York Public Library relating to prints and their production," compiled by F. Weitenkampf (1915), and also to Dr. Ludwig Choulant's articles on illustrated incunabula relating to natural history and medicine.

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SCIENTIFIC EVENTS

CALIFORNIA PETROLEUM

WITHIN a few days there will be issued the Report of the Committee on Petroleum of the California State Council of Defense. The members of the Committee on Petroleum are:

Max Thelen, president California Railroad Commission, chairman,

Eliot Blackwelder, professor of geology, University of Illinois,

David M. Folsom, professor of mining, Stanford University.

The committee was appointed by Governor Wm. D. Stephens on May 9, 1917, for the purpose of ascertaining and reporting to him the facts with reference to the production, distribution and utilization of California petroleum and its products. The report has been approved by Governor Stephens and has been forwarded by him to President Wilson with an urgent plea for action by the federal government to solve California's and the nation's petroleum problem.

The report consists of 12 chapters, as follows:

Chapter I. Letter of Transmittal.
Chapter II. World Petroleum Situation.
Chapter III. California Petroleum Fields.
Chapter IV. Production of California Petroleum.
Chapter V. Storage of California Petroleum.
Chapter VI. Transportation of California Petroleum.
Chapter VII. Refining of California Petroleum.
Chapter VIII. Utilization of California Petroleum.
Chapter IX. General Review—Production and Consumption.
Chapter X. Production—Maintenance and Increase.
Chapter XI. Conservation.
Chapter XII. Conclusions and Recommendations.

Chapter XII. contains the committee's conclusions and recommendations, and the two preceding chapters deal with the possibilities, respectively, of increasing the supply and of decreasing the consumption of California petroleum and its products.

THE STATES RELATIONS SERVICE AND AGRICULTURAL INSTRUCTION

Resolutions were passed at a conference in Washington on May 5, 1917, by representatives of the National Association of State Universities, the Association of American Agricultural Colleges and Experiment Stations, the Association of American Universities, the Association of American Colleges, and the institutional committee of the Society for the Promotion of Engineering Education, requesting the advisory commission to recommend to the Council of National Defense that it approve the plan of developing and issuing at once through the States Relations Service of the U. S. Department of Agriculture a statement of a comprehensive policy of cooperation between the government and the universities, colleges and other schools which will make for the most effective use of these institutions along agricultural lines throughout the duration of the war. In order to carry out this program the States Relations Service has appointed the following committee:

Professor G. A. Works, Cornell University.
Mr. L. H. Dennis, director of vocational agricultural instruction.
Professor H. F. Cotterman, Maryland State College of Agriculture.
Dr. O. H. Winkler, University of West Virginia.
Professor F. B. Jenks, University of Vermont, secretary.
Mr. C. H. Lane, States Relations Service, chairman.

The States Relations Service will bring this committee together in Washington from time to time, as may seem expedient, with the committee on education of the advisory commission for the consideration of the best methods of maintaining, adjusting and strengthening the agricultural instruction of the country in order to meet the emergencies of the war and to plan for the period following the war.

MEDICAL STUDENTS AND THE DRAFT

The Provost Marshall General has sent the following to governors of all states:

The President prescribes the following supplemental regulations governing the execution of the selective-service law.

First. Hospital internes who are graduates of well-recognized medical schools or medical students in their fourth, third, or second year in any well-recognized medical school who have not been called by a local board may enlist in the Enlisted Reserve Corps provided for by section 55 of the national defense act under regulations to be issued by the Surgeon General, and if they are thereafter called by a local board they may be discharged on proper claim presented on the ground that they are in the military service of the United States.

Second. A hospital interne who is a graduate of a well-recognized medical school or a medical student in his fourth, third, or second year in any well-recognized medical school, who has been called by a local board and physically examined and accepted and by or in behalf of whom no claim for exemption or discharge is pending, and who has not been ordered to military duty, may apply to the Surgeon General of the Army to be ordered to report at once to a local board for military duty and thus be inducted into the military service of the United States, immediately thereupon to be discharged from the National Army for the purpose of enlisting in the Enlisted Reserve Corps of the Medical Department. With every such request must be inclosed a copy of the order of the local board calling him to report for physical examination (Form 103), affidavit evidence of the status of the applicant as a medical student or interne and an engagement to enlist in the Enlisted Reserve Corps of the Medical Department.

Upon receipt of such application with the named inclosures the Surgeon General will forward the case to the Adjutant General with his recommendations. Thereupon the Adjutant General may issue an order to such interne or medical student to report to his local board for military duty on a specified date, in person or by mail or telegraph, as seems most desirable. This order may issue regardless of the person's order of liability for military service. From and after the date so specified such person shall be in the military service of the United States. He shall not be sent by the local board to a mobilization camp, but shall remain awaiting the orders of the Adjutant General of the Army. The Adjutant General may forthwith issue an order discharging such person from the military service for the convenience of the government.

Three official copies of the discharge order should be sent at once by the Adjutant General to the local board. Upon receipt of these orders the local board should enter the name of the man discharged on Form 164A and forward Form 164A, together with two of the certified copies of the order of discharge, to the mobilization camp to which it furnishes men. The authorities at the mobilization camp will make the necessary entries to complete Form 164A, and will thereupon give the local board credit on its net quota for one drafted man.

SCIENTIFIC MEN AND NATIONAL SERVICE

ON August 15, the Editor of SCIENCE addressed the following letter to the Surgeon General of the Army:

> I shall be under obligations to you if you are able to tell me what steps are being taken to make use in the medical service of the army of men who are conscripted who are not physicians but have scientific training that would enable them to render greater national service than by serving in the regular army. If you are willing to make a statement that could be printed in SCIENCE, it would assist many scientific men who are at present doubtful as to what they should do.

The following reply, dated August 29, has been received:

> In reply to your communication of August 15 requesting information relating to drafted men who possess scientific training, I beg to advise you that the Sanitary Corps of the United States Army, attached to the Medical Department, will accept a number of selected men who are not physicians but who have attained professional standing in bacteriology, chemistry and the several branches of engineering pertaining to sanitation. The Corps was organized specially to secure the services of skilled sanitarians having experience in both practical field work as well as those specially qualified in the several scientific branches having a correlation to the sanitary sciences.
>
> By order of the Surgeon General:
>
> C. L. FURBUSH,
> *Major, Medical Reserve Corps,*
> *United States Army*

SCIENTIFIC NOTES AND NEWS

PROFESSOR THEODORE LYMAN, of the department of physics at Harvard University, has received from the War Department a commission as captain in the aviation department of the United States Signal Corps, and has been ordered to report for active service in France. Professor Lyman has been since 1910 director of the Jefferson Physical Laboratory at Harvard.

PROFESSOR H. GIDEON WELLS, of the department of pathology of the University of Chicago, and head of the Otho S. A. Sprague Memorial Institute, has been appointed a member of the commission on behalf of the American Red Cross to go to Roumania for the purpose of investigating the conditions there and planning for Red Cross assistance in that field. He has been granted leave of absence by the trustees until January, 1918.

Professor Basil C. H. Harvey, of the department of anatomy of the University of Chicago, who has been appointed to the Medical Department of the United States Army, with the rank of captain, has been granted one year's leave of absence by the board of trustees. Assistant Professor Norman MacLeod Harris, of the department of hygiene and bacteriology, who has been serving abroad in the Canadian Medical Corps for the past year, has had his leave of absence extended for another year.

Professor Alfred Atkinson, of the department of agronomy, at the Montana State College, has been appointed by Mr. Herbert C. Hoover food commissioner of the state of Montana.

Professor Herbert W. Mumford, of the University of Illinois, is now associated with the Bureau of Markets of the United States Department of Agriculture as consulting specialist in live-stock marketing.

Dr A. C. Trowbridge, of the department of geology of the Iowa State University, has been made director of the Y. M. C. A.'s educational work at the Des Moines cantonment.

Robert A. Hall, Ph D. (Chicago), formerly assistant professor in physiological chemistry at the University of Minnesota, has been appointed to a lieutenancy in the army and is now on his way to France for immediate service.

Dr. Bennet M. Allen, professor of zoology in the University of Kansas, recently delivered an address on "Experiments upon the glands of internal secretion in amphibian larvæ" before the faculty and students of the graduate summer quarter in medicine of the University of Illinois.

Dr. Alonzo E. Taylor, of the University of Pennsylvania, member of the advisory board of food division of the surgeon-general's office, will visit the several medical officers' training camps and deliver a series of lectures on food values, food needs, and preparation and conservation of food.

The board of regents of the University of Michigan have approved a plan of Professor Henderson, director of the extension service, for the giving of about fifty extension lectures before the troops to be gathered at the Battle Creek Cantonment. These lectures are to be given by members of the faculty without compensation, and with the reimbursement by the university to them of their actual traveling and hotel expenses, for which the university extension fund already provides.

The Paris Academy of Sciences has received a gift from Mme. Beauregard to found a memorial to M. Clément Félix, the well-known electrical engineer.

Dr. C. O. Trechmann, of Hartlepool, England, who, while engaged in the manufacture of Portland cement, made contributions to mineralogy, crystallography and entomology, died on June 29.

George Wilber Hartwell, professor of mathematics and registrar in Hamline University, St. Paul, died on July 23 of appendicitis. Dr. Hartwell was born in New Jersey in 1881 and was graduated from Wesleyan University in 1903. After two years spent in teaching in the Michigan Agricultural College, he went to Columbia University on a fellowship, and there took the Ph.D degree in 1908. After filling a one-year vacancy in the University of Kansas, where he was elected to Sigma XI, he went to Hamline University as professor. The year following he became registrar, and continued in these positions until his death. He was a member of the American Mathematical Society and several similar foreign societies. The correspondent who sends us this information writes that Dr. Hartwell was not only a scholar of brilliant powers, but he was an executive officer of such tact and ability and a man of such decision and force that his loss to the college and his associates can hardly be estimated.

At Liverpool University an advisory committee of ten members has been formed in order to develop the chemical industry after the war; it consists of four members of the chemical staff of the university and six others representing the chemical industries.

The annual meeting of the American Public Health Association, which was to have been held in New Orleans in December, will be held in Washington by direction of the executive committee. War hygiene will be the central theme of discussion, and Washington is the city where information regarding the sanitary problems of armies is being concentrated.

THE installation of a new aquarium at Woods Hole Station of the Bureau of Fisheries was completed on July 5, under the direction of Superintendent Harron, of the central station. The aquarium consists of 10 tanks, which are arranged along the western and northern sides of the exhibition room of the hatchery building The old grotto is entirely displaced. The front of the aquarium is stained to represent Spanish oak. The interiors of the tanks are decorated with beach rocks of various sizes secured in the vicinity. The tanks were those used at the San Francisco exposition for the bureau's exhibit, but it was necessary to alter them in order to adapt them to the space allotted at Woods Hole. The aquarium makes a very pleasing exhibit and will be appreciated by the thousands of people who annually visit the station, in addition to serving a useful purpose in the scientific and fish-cultural work.

DR. MACNAMARA, a member for North Camberwell, in answering a question put in the British House of Commons, defined the functions of the Board of Invention and Research as follows: (*a*) To concentrate expert scientific inquiry on certain definite problems, the solution of which is of importance to the naval service; (*b*) to encourage research in directions in which it is probable that results of value to the navy may be obtained by organized scientific effort; (*c*) to consider schemes or suggestions put forward by inventors and other members of the general public. The board considers all inventions relating to naval warfare and acts in an advisory capacity to the Admirality. It has funds at its disposal for carrying out trials and experiments and possesses full facilities for arriving at a decision whether an invention is worthy of adoption or not; but the adoption of an invention is subject to the approval of the Board of Admiralty. The general superintendence of the Board of Invention and Research is reserved to the First Lord, to whom it has direct access. The Central Committee meets once a week; the panel once every six weeks, and the subcommittees hold meetings at frequent intervals as the circumstances require. The president has attended 54 sittings during the last 12 months. Dr. MacNamara also stated that the members of the board who received remuneration for their services were the president, £1,350 a year, in addition to retired pay; Vice-admiral Sir Richard H. Peirse (naval member of Central Committee), £1,530 a year; Professor W. H. Bragg (member of Panel), whilst occupying the post of resident director of research at an Admiralty experiment station, professorial salary of £1,000 a year at the University of London is refunded by the Admiralty to the university authorities; Dr. Dugald Clerk (member of Panel), as director of engineering research at the Admiralty Engineering Laboratory, City and Guilds (Engineering) College, South Kensington, is entitled to repayment of out-of-pocket expenses to an amount not exceeding £600 a year.

WE learn from the *Journal of Industrial and Engineering Chemistry* that through a coöperative agreement with Cornell University, representatives of the Bureau of Mines have been stationed at Morse Hall, where the electric furnace equipment of the department of chemistry has been utilized in some metallurgical work of the bureau. Experiments on the electric melting of brass have indicated that a suitable electric furnace might materially reduce the metal losses from volatilization and avoid the use of costly crucibles. The bureau is now testing a commercial-size furnace with special attention to its suitability for use on brasses for cartridges and shrapnel cases. Another electric furnace problem studied by the bureau has been the production of ferrouranium from the uranium oxide obtained as a by-product in the extraction of radium from its ores. Ferro-uranium is used in making uranium steel, which is said to be used by Germany for the lining of big guns which will stand up at a rate of fire so rapid that other steels fail. It is undecided whether the work on gun steel will be done at Cornell or some other university.

It is reported in *Nature* that in order to promote the further development of the dye-making industry in the United Kingdom, the president of the Board of Trade has decided to establish a special temporary department of the board to deal with matters relating to the encouragement, organization, and, so far as necessary, the regulation of that industry. The department will be under the direction of Sir Evan Jones, Bart., who has placed his services at the disposal of the president, and will have the official title of commissioner for dyes. The commissioner will act in close consultation with the various dye-making and dye-using interests concerned.

The United States Geological Survey, Department of the Interior, has issued as Bulletin 645 its "Bibliography of North American Geology for 1915," by J. M. Nickles. This bulletin is a list of the books, papers and maps bearing on the geology (including the paleontology, petrology and mineralogy) of North America and adjacent islands, and of Panama and Hawaii, issued in 1915. The papers are arranged alphabetically by names of authors and the bulletin contains a full alphabetical subject index by which any paper relating to any particular subject or area may be readily found. This bibliography is one of a series, the volume for 1911 forming Bulletin 524, that for 1912 Bulletin 545, that for 1913 Bulletin 584 and that for 1914 Bulletin 617. From time to time these bibliographies are combined in a single volume covering several years. The series now covers the literature of American geology from 1732 to the end of 1915.

The annual report on the Science Museum, and on the Geological Survey of Great Britain and Museum of Practical Geology, has been published as a White Paper for the Board of Education. According to an abstract in the London *Times* both museums have been closed to the public since March 6, 1916, but the scientific work has been continued so far as was possible under present conditions. The Science Museum remained open to students and for special purposes, the daily average of visitors after March being 132, as against 986 formerly. To the horology section Mr. Evan Roberts contributed over 200 watches and watch movements, of much historical and technical interest. The library of the London Mathematical Society was transferred and deposited on loan in the Science Library, and is being catalogued. The number of readers was 6,832, of whom two thirds were science teachers or students of the various colleges. The Geological Survey has also suffered from the war, which in turn has made special demands on the staff. Consultations and correspondence relating to military establishments at home and abroad have been frequent. Progress has been made with the "Series of special reports on the mineral resources of Great Britain," and with the standardizing of six-inch maps. The petrographical department has helped the Admiralty in the matter of aeroplane compasses, and the photographic work included the copying of maps and diagrams for military purposes and the making of microphotographs for the Admiralty. The Museum of Practical Geology was visited by 7,227 persons between January 1 and March 6, when it was closed to the public except for special inquiries. Donations during the year include a series of specimens, mainly rocks, from the western front, and igneous rocks from Imbros and Lemnos.

The Research Defense Society of Great Britain, owing to the continuance of the war, has again decided to postpone its annual general meeting. The committee's report of the work of the society during the past two years, as reported in *The British Medical Journal,* states that the inaction of the opponents of research had necessarily made the society less active. There had hardly been any controversy in the newspapers, and all through the country the great advances made in protective medicine due to research were being appreciated and better understood. The lectures given had been concerned more with the general influence of scientific medicine on the health and efficiency of the army than with experiments on animals. The Association for the Advancement of Medicine by Research decided last year in favor of amalgamation with the Research Defense Society, and the president and honorary treasurer of the association, Sir Thomas Barlow and Dr. Hale White, have joined the committee of the society. It is hoped that in the coming years there will hardly be any need for disputes with antivivisection societies, and that the society's best opportunities for usefulness will be found in wide, non-aggressive educational work.

We learn from *Nature* that the pensions granted during the past year by the British government include the following: Mrs. Charlton Bastian, in consideration of the services to science of her late husband, Dr. Charlton Bastian, and of her straitened circumstances, £100; Mrs. Minchin, in consideration of the scientific work of her late husband, Professor E. A. Minchin, and of her straitened circumstances, £75; Mrs. Albert Günther, in consideration of the scientific work of her late husband, Dr. Albert Günther, and of his distinguished services to the British Museum as keeper of zoology, £70; and Mrs. Roland Trimen, in consideration of the eminent services of her late husband to biological science, and of her straitened circumstances, £75.

UNIVERSITY AND EDUCATIONAL NEWS

The will of Mrs. Robert W. Bingham, wife of Judge Robert Bingham, of Louisville, Ky., a graduate of the University of North Carolina, gives to the University of North Carolina $75,000 a year for the establishment of professorships and ultimately a capital sum producing this amount. The professorships are to be known as Kenan professorships, in memoriam of Mrs. Bingham's father, William R. Kenan, and her uncles, Thomas S. Kenan and James Graham Kenan, graduates of the university. The value of this bequest to the University of North Carolina is more than a million and a half dollars.

Francis A. Thomson has resigned from the faculty of the State College of Washington to accept the deanship of the school of mines at the University of Idaho, Moscow, Idaho.

Dr. Wallace Buttrick, member of the executive committee of the Rockefeller Foundation and director of its China Medical Board, is in England on the invitation of a department of the British government to confer with educators and officials in Great Britain concerning public education.

At the University of Chicago the following promotions from associate professorships to professorships have been made: Basil C. H. Harvey, of the department of anatomy; Horatio Hackett Newman, of the department of zoology; J. Paul Goode, of the department of geography; Walter Sheldon Tower, of the department of geography. From an assistant professorship to an associate professorship: Arthur C. Lunn, of the department of mathematics.

At the New Hampshire College A. W. Richardson, of the University of Maine, has been appointed assistant professor in charge of the poultry department to succeed R. V. Mitchell, and G. A. Minges, of Iowa State College, has been appointed instructor in chemistry. The chemistry department has lost two members owing to the war: Professor G. A. Perley has been granted leave of absence for the period of the war and is serving as first lieutenant in the division of chemical engineering, U. S. Army, and Arnold J. Grant has gone to the second Plattsburg Camp.

DISCUSSION AND CORRESPONDENCE

THE PUBLICATION OF SCIENTIFIC RESEARCH

To the Editor of Science: A matter in which there is a considerable divergence between the practise of different laboratories is that of the method of publication of their results. A number of laboratories publish their own bulletins, either as separate papers or as periodical volumes. Others publish in the scientific and technical press, either in one or two journals or in a number of different journals according to the subjects dealt with.

Naturally, the best method of publication will depend to some extent on the nature of the work published and the character of the laboratory. In the case of a purely technical laboratory publishing a large number of papers dealing with one special, technical subject, the method of publishing separate bulletins mailed directly to a selected list of those interested may be quite satisfactory, but if the publications of a laboratory cover a large range of subjects it would seem to be preferable to publish each paper in the journal which deals with the department of science most akin to that of the subject dealt with. If this is not done, there is a grave danger that the paper may be missed by the abstract journals and may fall out of sight altogether, while in any case the publication of single bulletins throws a heavy burden on any investigator engaged in compiling a bibliography of a subject.

In this laboratory we have confined the publication of our scientific communications to the recognized technical and scientific journals, and I find that our first fifty communications have been published in no less than seventeen different journals, twenty-eight being published in journals relating to some branch of physics, five in chemical journals, and seventeen in photographic publications.

Since it is an advantage for all the papers issued from one laboratory, which, naturally, have a common interest, to be available in some collected form, we issue periodically bulletins containing abridgments of all our scientific papers, the second volume of these bulletins containing the papers published during 1915 and 1916 being now ready.

It would be of interest to learn the views of others interested in this question as to the relative advantages of the issue of separate bulletins as compared with publication in the current press. C. E. K. Mees

Research Laboratory,
Eastman Kodak Company

POPULAR SCIENCE

Unwarranted deductions have been drawn in a recent popularization of science by one of our eminent paleontologists, Dr. H. F. Osborn, not however in his own field, but in a special field apparently unfamiliar to him. Lest others may be misled into thinking that the deductions are based on good evidence, may I be permitted space to call attention to them.

Dr. C. D. Walcott has recently reported[1] the discovery in an Algonkian limestone of fossils having appearances and associations which give valid reasons, though not positive proof, for thinking them to be bacteria. The finding of these fossils in a limestone rock in association with fossil algæ as well as other related facts lends support to his previous suggestion[2] that this limestone was probably partially deposited by bacterial action in a manner similar to that described by G. H. Drew[3] as taking place to-day in the tropical waters about the Bahamas. A reference back to the article by Drew shows that the bacterium which he found causing the depositation of $CaCO_3$ is a denitrifier which he has named *Bacterium calcis*. It is an organism similar to other denitrifiers, possessing the power to reduce nitrates to nitrites with the later disappearance of the nitrite accompanied by the formation of ammonia and a gas which, from the few simple tests made, was in all probability free nitrogen. Like other denitrifiers, this organism was found to possess the power of utilizing organic carbon in the form of sugars and even possessed the power of secreting ectoenzymes capable of liquefying organic nitrogen compounds like gelatin. The precipitation of the calcium carbonate is explained as due to the increase in the concentration of CO_3 ions caused by the advent of $(NH_4)_2CO_3$, which is partially ionized into NH_4 and CO_3 ions.

If the validity of the evidence that the fossils found are bacterial in nature is admitted, and it is assumed that the particular fossils in question are of the organisms which were instrumental in having caused the deposit of limestone, then the deduction might be drawn that these fossils are those of denitrifying bacteria. The fact that Dr. Walcott refrained from making this deduction is quite probably due to the fact that he had a feeling that it would be based on too many "ifs."

Turning now to the article by Dr. Osborn[4] we find that he has not been as cautious and that he sees in Dr. Walcott's fossil bacteria certain resemblances in appearance and structure to nitrogen-fixing bacteria from soil (by context the bacteria referred to appear to be *Azotobacter* and related forms). He is not dismayed by the fact that the metabolism of marine, denitrifying, lime-depositing bacteria, and that of the nitrogen-fixing bacteria in soil which utilize both atmospheric nitrogen and organic carbon, are in a sense opposed to each other. Still less is he troubled by the very great difference between the metabolism of nitrogen-fixing bacteria and the autotrophic, nitrifying bacteria like *Nitrosococcus* and *Nitrosomonas* organisms which do not utilize organic food and derive their nitrogen from ammonium salts instead of free nitrogen). In fact, he apparently thinks of the nitrifying and the nitrogen-fixing bacteria as essentially identical, as appears in the following statement (p. 292):

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[1] *Proc. Nat. Acad. Sci.*, 1: 256–257, 1915.

[2] *Smiths. Misc. Coll.*, 64: 76–156, 1914.

[3] Papers from Tortugas Lab., 5: 8–45, 1914, Pub. 182, Carn. Inst. Wash.

[4] *Sci. Monthly*, 3: 289–307, 1916.

> The great antiquity of even higher forms of bacteria feeding on atmospheric nitrogen is proved by the discovery, announced by Walcott in 1915, of a species of pre-Paleozoic fossil bacteria attributed to "*Micrococcus*" but probably related rather to the existing *Nitrosococcus* which derives its nitrogen from ammonium salts.

The illogical nature of this statement may be brought out by substituting groups more familiar to paleontologists than are bacteria. Thus we have:

> The great antiquity of Carnivores feeding on flesh is proved by the discovery of a species of pre-Paleozoic mammal attributed to Herbivores, but probably related rather to Rodents who derive their food largely from grain and nuts.

Needless to say that Dr. Osborn would be the first to see the weakness in such a statement. In reality this paraphrase does not exaggerate the illogical nature of the original statement, though it may appear to do so to the layman unfamiliar with the fact that great differences in these tiny organisms are very frequently hidden behind superficial resemblences in appearance.

The almost universal uniformity in protoplasmic structure of living species of bacteria and their universal possession of a definite membrane which gives them definite form will cause bacteriologists to wonder at the statements on the following page of Dr. Osborn's article where he says:

> The cell structure of the Algonkian and of the recent *Nitrosococcus* bacteria is very primitive and uniform in appearance, the protoplasm being naked or unprotected.

Any one who looks at the uniform black of the fossil organisms in the microphotographs given and who realizes that these are pictures of fossils and not of living organisms will be skeptical in regard to the evidence on which this statement is based.

Statements based on evidence of the sort furnished which claim that the presence in the Algonkian of nitrifying, denitrifying or nitrogen-fixing bacteria has been shown appear like a pyramid of speculation supported on an apex of fact. They have, however, already misled a bacteriologist into an acceptance of one of these claims, for I. J. Kligler[5] says in a recent paper (p. 166):

> Finally Walcott's discovery of bacteria closely resembling our nitrogen fixers of the soil is added proof of the primitiveness of these microbes.

It is because of the great interest of the findings by Drew and Walcott, that this word of warning has been uttered to protect science from conclusions which others have drawn from them. If this is not done there is danger that the next time reference is made to their work it will be in some textbook as a positive statement that nitrifying, denitrifying or nitrogen-fixing bacteria, or all three, have been shown to exist as far back as the Algonkian.

R. S. BREED

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MAN AND THE ANTHROPOID

TO THE EDITOR OF SCIENCE: In the July 27 number of SCIENCE Prof. Mattoon M. Curtis devotes a column and a half to a criticism of the "common error" that man is a lineal descendant of the anthropoid apes. "The evident implication," he tells us, "is that the extant anthropoids, orang, gibbon, gorilla and chimpanzee are intended." He proceeds to cite Duckworth to prove that this is an error, and concludes, so far as one can judge of his meaning, that man and the anthropoids are "not genetically related"—an amazing *non sequitur*.

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[5] *Jour. Bact.*, 165–176, 1917.

One may parallel his argument in some such form as this: The existing Nordic peoples are currently asserted to be descendants of primitive races of man. The evident implication is that the extant primitive races, negroes, Australians, Red Indians, and Polynesians are intended. But Professor Ripley has recently shown that none of these races, constituted as they now are, figured in the ancestral history of the Nordic race. This may relieve our anxieties lest we might be descended from savages. While we do not know as much about such creatures as we might, it is perfectly clear that there is nothing to the absurd tradition that we Nordics are descended from them or they from us. It appears to be a sound principle that groups showing inverse developments are not genetically related, and it is well known that the Nordics are unusually light-colored while the savage races are remarkably dark; that the high and straight nose of the Nordic and his blue eyes are not to be found in these so-called inferior races of mankind; while most of them display thick lips which do not appear in the Nordic race.

And so on—but this surely is a sufficient *reductio ad absurdum*. Who believes that the human race is descended from the *existing* anthropoid apes? Who ever did that knew anything about it? How could it be so? How could prehistoric human beings be descended from anthropoids still living, unless, like Rider Haggard's "She," they were endowed with eternal life to outlive their descendants? Surely the writer can not but know that the current assertion means and can mean only that man is descended from the same ancestral stock as the anthropoid apes. What that ancestral stock was like, and how far and in what directions its living descendants have departed from it, is the problem which the "scientists" (whom he puts in "quotes" apparently intended in some obscure derogatory sense) are trying to find out, by the inferential evidence of anatomy, physiology, and kindred sciences, and by the direct but as yet scanty evidence of paleontology and archeology.

The final paragraph opens with a curious sentence which I quote:

> Whether "scientists" are entitled to believe what they please or are to be guided by observations and verifications is perhaps an open question.

Possibly I am mistaken and Mr. Curtis means by "scientists" the followers of Mrs. Eddy. I don't know their principles very well, but very possibly they do consider themselves entitled to "believe what they please" irrespective of evidence other than the assertions of "Science and Health." But surely no scientific man—without quotes—thinks himself entitled to believe anything regarding science save upon the evidence of observations and conclusions made and verified by himself and others. Nor does anybody else. The attitude is not peculiar to science. It is the ordinary man's attitude towards the common world about us; and science has no other attitude than that.

It is difficult to see in this letter anything save an attempt to discredit theories which the writer, without knowing much about them, does not wish to believe. I can hardly suppose that many readers of SCIENCE will take the argument seriously, in spite of a not inconsiderable dialectic skill. But however appropriate in some theological journal it appears somewhat in the category of "eccentric literature" in its present surroundings.

W. D. MATTHEW

SCIENTIFIC BOOKS

Bibliography of William Henry Welch, M.D., LL.D., 1875–1917. Prepared by WALTER C. BURKET, M.D., with foreword by HENRY M. HURD, M.D. Baltimore, The Johns Hopkins Press. 47 pp. 4°.

This is a notable contribution to medical bibliography, in the special sense of the term, which implies an exhaustive and accurate index of all the books and periodical papers under a given subject or author, as distinguished from the bibliophilic sense, in which a book, incunabula or manuscript is described, like an object in natural history, in such a complete and unmistakable manner that its identification is always possible from the description. The scattered scientific papers and the varied public activities of Professor Welch are here set forth, for the first time, in a strict chronological order, which will be most useful to future medical historians and biographers. No one, for instance, could gain any just conception of the versatile and genial scientific work of Virchow or Weir Mitchell who has not gone over the "Virchow-Bibliographie" of 1901 or the catalogue which Mitchell himself prepared in 1894. As much of the best scientific literature of medicine is buried in the endless files of medical periodicals, medical bibliography, as standardized by Billings and Fletcher, enjoys the status of firearms in the early days of the far West—"sadly missed when badly wanted." The Welch bibliography, as Dr. Hurd tells us in the preface, has required the investigation of years, and is now printed because the interruptions of the present war have prevented the publication of the collective writings. In the first half of Dr. Burket's list (1875–1900), we find the larger scientific contributions of Welch, the great laboratory physician, his early investigations of the pathology of pulmonary œdema (1875), glomerulonephritis (1886), the structure of white thrombi (1887), his Cartwright lectures on the pathology of fever (1888), his discoveries of the staphylococcus which infects the edges of wounds (1891), and (with Nuttall) of the bacillus aerogenes capsulatus (1892), now of immense moment in Europe as the cause of gas infection in gunshot wounds, his synthesis of the many nondescript diseases caused by this bacillus (1900), his experiments (with Flexner) on the effects of injection of diphtheritic toxins (1891–2) and his monographs on thrombosis and embolism (1899). In his later period, Welch has been content to see his pupils carry out investigations inspired by him, so that the latter half of the bibliography, while replete with contributions on purely medical themes, is characterized by those addresses on public occasions in which Welch always acquits himself with the grace and charm of some distingué French academician.

As one who has had latterly to devote much of his time to the public good, Welch, like Dr. Johnson's Mead, has "lived more in the broad sunshine of life than any man." Many of the papers listed in this bibliography are described as "unpublished," which perhaps accounts for the appearance of the bibliography before the actual collected writings. Among, these, it is to be hoped that the many charming extempore talks at the Johns Hopkins Historical Club will be included. On such occasions, Welch, when the humor strikes him, improvises delightfully upon a set theme, like some genial musician of the past. The well-known "Ether Day Address" on "The Influence of Anæsthesia upon Medical Science" (1896) was written out without preparation in a railroad car, as he traveled to Boston, a fair example of his habit of improvisation. The two addresses on the evolution of scientific laboratories (1896) and the interdependence of medicine and science (1907), the latter also written out *en route* for Chicago, are perhaps the most interesting of Welch's contributions to medical history. Here, as everywhere, he has furnished young and old with food for thought, and often with new ideas. Dr. Burket is to be congratulated on the excellence and accuracy of his work, which follows the bibliographic norms set by the Surgeon General's Library. It is a most timely contribution. In the present emergencies, no man has labored more zealously and faithfully for the welfare of his country than William H. Welch. F. H. Garrison

Army Medical Museum

SPECIAL ARTICLES

WHAT SUBSTANCE IS THE SOURCE OF THE LIGHT IN THE FIREFLY?

In at least three groups of luminous animals (fireflies, ostracod crustacea and mollusks), two distinct chemical substances, besides water and oxygen, are necessary for light production. One of these is not destroyed by heat and is easily dialyzable; it can be prepared by extracting luminous animals with hot water. This substance has been termed *luciferin* by Dubois[1] and *photophelein* by myself.[2] The second substance is destroyed by heat and does not dialyze; it can be prepared by allowing a water extract of the luminous organ to stand until the light disappears. This has been called *luciferase* by Dubois[1] and *photogenin* by myself.[2] Whenever solutions (non-luminous) of these two substances are mixed, light immediately appears and is brighter the greater the concentration of the solutions.

According to Dubois, the thermolabile substance, luciferase (photogenin) is an oxidizing enzyme (hence the termination *ase*), which oxidizes the thermostable substance, luciferin (photophelein), which is therefore the source of the light. My own work has led me to belive that the thermolabile substance is not an enzyme, but is itself the source of the light and I have indicated this by calling it photogenin (phos, light; gennao, produce). The thermostable substance is, according to my view, a material which assists in the production of light and I have indicated this by calling it photophelein (phos, light; opheloo, assist).

Which is the source of the light, photogenin (luciferase) or photophelein (luciferin)? Fortunately the question can be answered by a simple crucial experiment. The two common eastern genera of fireflies produce light of different colors. *Photinus* emits an orange light, while *Photuris* emits a greenish yellow light. The difference in color is especially noticeable when the luminous organs of the two species are ground up in separate mortars. As shown by Coblentz,[3] the difference in color is real; the spectrum of *Photinus* extending further into the red than that of *Photuris*. The two light-producing substances can be prepared from each of the two species, and the photogenin of *Photinus* mixed with its own photophelein gives an orange light, while the photogenin of *Photuris* mixed with its own photophelein gives a greenish-yellow light, the color characteristic of the species. The two genera may also be "intercrossed" with respect to the two light-producing substances, *i. e.*, the photogenin of *Photinus* gives light with the photophelein of *Photuris* and vice versa. If the source of light is photophelein (luciferin) as Dubois believes, the light produced by *Photinus* photophelein (luciferin) × *Photuris* photogenin (luciferase) should be orange, the color characteristic of *Photinus*. I have found, on the contrary, that the light from this "cross" is greenish yellow. Conversely, the light from a mixture of *Photinus* photogenin (luciferase) and *Photuris* photophelein (luciferin) is orange. The color of the light in these "crosses" is that characteristic of the animal supplying photogenin (luciferase). The photogenin (luciferase) must, therefore, be the oxidizable substance and the source of the light.

How does photophelein assist in the production of light? The process is best studied in the marine ostracod crustacean, *Cypridina hilgendorfii*. The photogenin and photophelein of this animal are secreted into the sea water together, and in time the photophelein is used up and a perfectly clear colorless non-luminous solution of photogenin remains. If we add to such a concentrated solution, photophelein or certain specific substances in extracts of non-luminous forms, or fat solvents such as ether, chloroform and higher alcohols, or thymol, saponins, soaps, bile salts, or crystals of inorganic salts, such as NaCl, light appears. Many of these substances are not oxidizable (another proof of the inadequacy of Dubois's theory), but all of them are cytolytic agents. The cytolytic action of these substances on cells is the result of a dissolving action on the cell surface involving an increased dispersion of the colloids which results in the complete solution and dissolution of the cell. Photogenin is a colloid and I would suggest that these substances have a similar action on the colloidal particles of photogenin. We are not dealing here with a cytolysis of cell fragments present in the secretion, since these cytolytic agents (salts, thymol, etc.) cause light production even in solutions of photogenin filtered through porcelain or siliceous filters which remove all granules and cell fragments. I would suggest, therefore, as a working hypothesis rather than a formal theory, that photophelein acts by changing the aggregation state of the colloidal particles of photogenin toward that of greater dispersion, thus increasing the surface of the particles. It is known that oxidation occurs at the surface of many colloidal particles, and light production might easily result from auto-oxidation accompanying the dispersion of the colloidal particles.

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[1] Dubois, R., *C. R. Soc. Biol.*, 1885, XXXVII., 559, and *Ann. de la Soc. Linn. de Lyons*, 1913, LX., and 1914, LXI., 161.

[2] Harvey, E. N., Science, N. S., 1916, XLIV., 652, and *Amer. Jour. Physiol.*, XLII., 318, 1917.

[3] Coblentz, W. W., Carnegie Inst. Wash. Pub. No. 164, 1912.

Photopheleins from different species of animals have different chemical properties and, like the cytolysins, they are also specific to a considerable degree. Firefly photophelein will produce light on mixing with photogenin of other insects (*Pyrophorus*), but none or very faint light on mixing with photogenin from *Cypridina*. A non-luminous species of *Cypridina* contains a photophelein with marked light-producing action on the photogenin of the luminous *Cypridina*, but none with firefly photogenin. Photophelein, therefore, is to be compared with the specific cytolytic substances of blood sera, with this exception, that it is the photophelein of the same species which has the greatest light producing action whereas the blood of the foreign species is the one possessing the greatest cytolytic (hemolytic) power.

E. NEWTON HARVEY

PRINCETON UNIVERSITY

INOCULATIONS ON RIBES WITH CRONARTIUM RIBICOLA FISCHER[1]

THE white pine blister rust is established in the native white pine growth of many parts of New England. Since, in most sections of New England, the pine far outvalues the cultivated currants and gooseberries, the latter, together with the wild *Ribes*, are being removed to hold the disease under control. A cultivated currant or gooseberry, not susceptible to the disease and possessing commercial qualities, would be of much practical importance for future planting within the diseased area. Even a wild species of *Ribes* immune to the disease might be of value for breeding new resistant commercial varieties to replace those now being removed. For the purpose of discovering such resistant varieties or species of *Ribes*, inoculations under controlled conditions have been made during the past three years on 82 varieties of cultivated red, black and white currants, 23 varieties of cultivated gooseberries, and 48 species and hybrids of *Ribes* from various parts of the world. Field tests are also being made with many of the above varieties and species.

The varieties of a cultivated species show considerable variation in the degree of their susceptibility to the disease. The cultivated species of *Ribes* also vary decidedly in susceptibility. Some varieties and some species, notably *Ribes nigrum*, are very congenial hosts for the rust, very abundant uredinia and telia being produced thereon. In other varieties and species the rust spreads rapidly over the leaf surface and produces abundant uredinia, but the leaf tissue often dies before many telia are formed. In other cases a few uredinia form, at which time irregular areas of the leaf tissue die quickly, with or without further spread of the fungus around the dead area. Sometimes, instead of a definite area being killed, small streaks or flecks are killed. These dead spots often enlarge slowly, producing occasionally a few uredinia or telia. All intergradations are found between *R. nigrum*, upon which the maximum number of fruiting bodies form, and *R. leptanthum*, on which small dead areas and flecks are formed, on less than 10 per cent. of which rust spores are produced. The vigor of the plant and the age of the leaves have an influence on the development of the disease. The size of the leaves has little influence, if they are relatively old, those less than one tenth normal size having taken the disease in a manner characteristic for the host species.

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[1] Published by permission of the Secretary of Agriculture.

In many cases inoculations have been made with æciospores as well as with uredospores, similar results being obtained upon the same host. In most cases both uredinia and telia were produced. It has been impossible thus far to have all the species authoritatively identified, that being done as fast as the development of the plants will permit. Therefore this list is subject to such changes as further study of the plants may cause. The synonymy of the group is based, for the North American species, on Coville's treatment in "North American Flora," issued by the New York Botanical Garden, and for the species of the rest of the world on Janczewski's "Monographie des Grosseilliers, *Ribes* L." and supplements to that work.

Successful inoculations have been made upon the following species: *Ribes alpestre* Dec., *R. alpinum* L., *R. americanum* Mill., *R. aureum* Pursh, *R. bracteosum* Douglas, *R. carrierei* hybrid, *R. cereum* Douglas, *R. coloradense* Coville, *R. cruentum* Greene, *R. culverwellii* hybrid, *R. curvatum* Small, *R. cynosbati* L., *R. diacantha* Pallas, *R. divaricatum* Douglas, *R. erythrocarpum* Coville & Leiberg, *R. fasciculatum* Seib. & Zucc., *R. fontenayense* hybrid, *R. futurum* hybrid, *R. giraldii* Janczewski, *R. glandulosum* Grauer, *R. glutinosum* Bentham, *R. gordonianum* hybrid, *R. hesperium* McClatchie, *R. hirtellum* Michaux, *R. holosericeum* hybrid, *R. inebrians* Lindley, *R. inerme* Rydberg, *R. irriguum* Douglas, *R. lacustre* (Persoon) Poir., *R. leptanthum* Gray, *R. lobbii*, Gray, *R. mensiesii* Pursh, *R. missouriense* Nuttall, *R. montigenum* McClatchie, *R. nevadense* Kellogg, *R. nigrum* L., *R. nigrum* var. *aconitifolium*, *R. odoratum* Wendl., *R. oxyacanthoides* L., *R. petraeum* Wulf., *R. reclinatum* L., *R. rotundifolium* Michaux, *R. sanguineum* Pursh, *R. setosum* Lindley, *R. speciosum* Pursh, *R. succirubrum* hybrid, *R. triste* Pallas, *R. viscosissimum* Pursh, *R. vulgare* Lam.

Successful inoculations have been made on numerous unidentified *Ribes* from all parts of the United States, including over one hundred collections made by R. K. Beattie in the Northwest and Pacific Coast States. Thus far no species has proved to be entirely resistant to the rust.

The writers acknowledge the aid of the following in carrying on these experiments and thank them for so kindly furthering the work: Mr. R. K. Beattie, Dr. G. R. Lyman, The Arnold Arboretum, The Forest Service and The Office of Horticultural and Pomological Investigations, Bureau of Plant Industry, United States Department of Agriculture.

PERLEY SPAULDING,
G. FLIPPO GRAVATT
OFFICE OF INVESTIGATIONS IN
FOREST PATHOLOGY,
BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

THE AMERICAN PHILOSOPHICAL SOCIETY. II

Naming American hybrid oaks: WILLIAM TRELEASE, Sc.D., LL.D., professor of botany, University of Illinois, Urbana.

Thirty-eight known or probable hybrids among the oaks of the United States have been brought together from various and much scattered publications. No cases are believed to exist in which a species of the white oak group (*Leucobalanus*) has intercrossed with a species of the red oak group (*Erythrobalanus*). To the 38 accepted hybrids already recorded, two are added in this paper—× *Quercus palæolithicola* (a cross between *Q. ellipsoidalis* and *Q. velutina*), and *Q. Schuettei* (a cross between *Q. bicolor* and *Q. macrocarpa*). Of the 40 recognized hybrids, 15 have been given binomials by earlier writers: the remaining 25 are here named for the first time, in accordance with international rules of procedure.

The wild relatives of our cultivated plants and their possible utilization: W. T. SWINGLE, Ph.D., U. S. Department of Agriculture. (Introduced by Dr. William P. Wilson.)

An annotated translation of de Schweinitz's two papers on the rusts of North America: JOSEPH C. ARTHUR, professor emeritus of botany, Purdue University, Lafayette, Indiana, and G. R. BISBY. (Introduced by Professor John M. Coulter.)

The most illustrious botanist of the first half of the last century to give attention to fungous plants was L. D. von Schweinitz, of Salem, N. C., and later of Bethlehem, Pa. He became a member of the American Philosophical Society just one hundred years ago, and some time later published in the *Transactions* of the society the earliest list of "North American Fungi." This attempt at a comprehensive list for the whole country was not again made until the present time, but now the work is in progress, divided among a number of men. The rusts are being listed by Professor J. C. Arthur, LL.D., of Purdue University, Lafayette, Ind. He now presents to the society an estimate of von Schweinitz's notable achievement with this group of fungous plants. Of the four thousand species of fungi on Schweinitz's list 135 were rusts, a class of parasitic fungi of the greatest economic importance. All of Schweinitz's collection, now deposited at the Philadelphia Academy of Sciences, has been critically examined and identified, and a record made of the present knowledge relating to each form. Dr. Arthur pays a high tribute to the remarkable showing made by Schweinitz, to his great accuracy and industry, and to the eminent services which he rendered to American botany.

Ecology and physiology of the red mangrove: H. H. Bowman, fellow in botany, University of Pennsylvania. (Introduced by Professor Harshberger.)

The mangroves have been noted by the ancient Greeks in early classic literature. Nearchus, the admiral of Alexander the Great, mentioned them as being observed on Alexander's expedition into Asia. They were found by the Greeks growing along the shores of the Persian Gulf and the Red Sea. Theophrastus, the pupil of Aristotle, wrote concerning them as well as Pliny, and many medieval and later travelers and explorers. An examination has been made of the microscopic structure of the various tissues of these trees from material collected in the Gulf of Mexico, along the lower Florida Keys. Particular attention has been paid to the presence of intercellular stone cells and to the occurrence of tannin cells. The physiological relations of transpiration and absorption of these plants growing in sea water and all dilutions of it, as well as fresh water, have been studied, and the law deduced that the rate of transpiration varies directly with the concentration of the medium. Biochemically, it has been shown that there is a definite relation between the amounts of sugar and tannin in the hypocotyls at different stages of growth of the plants. Ecological factors show their effect on various tissues, particularly those of the leaves, *e. g.*, the variation in leaf thickness and structure in off-shore, in-shore, salt-water and fresh-water plants. Geologically, the mangroves are of importance in building up land and increasing the area of dry land on islands and continents in the tropics. Under economic considerations it may be stated that the tannin contained in the tissues is used for tanning leather. The wood is the source of an excellent charcoal, but chiefly the plants have been used in keeping up embankments along the seashores and in building dams and dykes. The distribution of these trees along the Florida peninsula and keys is plotted in a series of maps.

Reception from eight to eleven o'clock at the hall of the Historical Society of Pennsylvania, when George Ellery Hale, Ph.D., Sc.D., LL.D., F.R.S., director of the Solar Observatory of the Carnegie Institution of Washington, at Mt. Wilson, Calif., gave an illustrated lecture on "The work of the Mt. Wilson Observatory."

APRIL 14

William B. Scott, Sc.D., LL.D., Vice-president, in the chair

Biochemical studies of the pitcher liquid of Nepenthes: Joseph S. Hepburn, M.S., Ph.D. (Introduced by Professor Harry F. Keller.)

The National Research Council and its opportunities in the field of chemistry: Marston T. Bogert, Ph.B., LL.D., professor of organic chemistry, Columbia University.

The South American Indian in his relation to geographic environment: William Curtis Farabee, A.M., Ph.D., curator of American Section of Museum, University of Pennsylvania. (Introduced by Mr. Henry G. Bryant.)

Interrelations of the fossil fuels: J. J. Stevenson, Ph.D., LL.D., emeritus professor of geology, New York University.

This paper deals with the Cretaceous coals, which are vastly more important in the United States than in all the rest of the world. After description of stratigraphical and chemical conditions observed in the typical areas, an effort is made to present the characteristic features in such fashion that the relations to peat and the Tertiary coals may be made clear.

The distribution of land and water on the earth: Harry Fielding Reid, Ph.D., professor of dynamic geology and geography, Johns Hopkins University.

Uplifted and dissected atolls in Fiji (illustrated): William Morris Davis, Ph.D., emeritus professor of geology, Harvard University.

In the southeastern part of the Fiji group a number of atolls uplifted several hundred feet above sea level, are now in various stages of dissection. In no case do they reveal a truncated volcanic platform; hence they discredit those theories of atoll formation which explain atolls or upgrowths of moderate thickness around the border of former volcanic islands that were reduced to submarine platforms by manual abrasion.

The slides on the Panama Canal: George W Goethals, LL D., Maj.-Gen. U. S. A., late chief engineer, Panama Canal.

Application of polarized light to study of ores and metals: Frederick E. Wright, Ph.D., of Geophysical Laboratory of Carnegie Institution of Washington.

In this paper the principles underlying the application of polarized light to the study of ores and metals are outlined. The possibilities and also the limitations of the different methods, new or old, now available, are indicated and the adaptation of these methods to metallographic and mineralographic work with the microscope is considered briefly.

Astrapotheria: William B. Scott, Sc.D., LL.D., professor of geology, Princeton University.

Diatryma, a gigantic Eocene Bird: William Diller Matthew, A.M., Ph.D., curator of vertebrate paleontology, American Museum of Natural History, New York. (Introduced by Professor W. B. Scott.)

The skeleton of a gigantic extinct bird was found last summer in the Bighorn basin of Wyoming by an expedition from the American Museum of Natural History. It is of Lower Eocene age, a contemporary of the little four-toed horse whose fossil remains are found in the same region. The bird was about as large as the extinct moas of New Zealand, much bulkier than any living bird, although not so tall as an ostrich. It stood nearly seven feet high. The head was enormous, eighteen inches long with huge compressed beak like the extinct *Phororhachos* of Patagonia, but unlike any living bird. The neck too was very massive and rather short, and it was quite unable to fly, the wings about as large as in the cassowary. Although it resembled the modern ostrich group in some ways, it was not related to them and only remotely related to any other known birds, the nearest perhaps being the *Seriema* of South America. A few fragments of this gigantic bird were found by the late Professor Cope over forty years ago, and named *Diatryma*, but it remained practically unknown until the discovery of this nearly complete skeleton. A description of this specimen by W. D. Matthew and Walter Granger, with photographs and a reconstruction, is now in press for the *Bulletin* of the American Museum.

AFTERNOON SESSION

William W. Keen, M D., LL.D., President, in the chair

Presentation of a portrait of I. Minis Hays, M.D., dean of the Wistar Association: Joseph G. Rosengarten, LL.D., on behalf of the Wistar Association, on the Centennial Anniversary of its organization and in the twenty-first year of Dr. Hays's Secretaryship of the Society.

Symposium on Aeronautics—

Dynamical aspects: Arthur Gordon Webster, Ph.D., LL.D., member of Naval Advisory Board.

Physical aspects: Brigadier-General George O. Squier, Ph.D., chief of Signal Corps, U. S. Army. (Introduced by Dr. Keen.)

Mechanical aspects: William Frederick Durand, Ph.D., chairman of National Advisory Committee for Aeronautics. (Introduced by Dr. Walcott.)

Aerology in aid of aeronautics: W. R. Blair, Ph.D., assistant, United States Weather Bureau.

Discussion—

Mathematical aspects: Edwin Bidwell Wilson, Ph.D., professor of mathematics, Massachusetts Institute of Technology. (Introduced by Dr. E. W. Brown.)

Engineering aspects: Jerome C. Hunsaker, Eng.D., assistant naval constructor, U. S. Navy. (Introduced by Dr. Bauer.)

On Saturday evening the usual banquet was held at the Bellevue-Stratford, about sixty-five members and guests being present.

The following toasts were responded to:

"The memory of Franklin," by President Hibben, of Princeton.

"Our sister societies," by Wm. H. Welch, M.D., of Johns Hopkins.

"Our universities," by Professor T. F. Crane, of Cornell.

"The American Philosophical Society," by Mr. John Cadwalader, of Philadelphia.

Arthur W. Goodspeed,
Secretary

SCIENCE

Friday, September 14, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ORGANIZED KNOWLEDGE AND NATIONAL WELFARE[1]

The future of any nation is secure if it lives up to its possibilities. The nation which does this is bound to be a leader among nations and to command world-wide respect. Its national problems will be solved and solved intelligently and thoroughly. The greatness of a man is in part born in him and in part the product of his environment. According to eminent biologists, he is about two fifths born and three fifths made. Similarly, a nation is great according to its resources and according to its development of these resources. And the development of those resources may be accomplished only through organized knowledge.

I. *The Function of Organized Knowledge*.—Consider for a moment two manufacturing concerns on an equal footing as regards output, but of which one is continually making progress through improvements in manufacturing processes, developing new and valuable products and investigating the fundamental principles underlying all these processes. This firm will in time outstrip the other in every way; the balance, in fact, is a very delicate one, since the results are cumulative. In quite a similar manner, that nation will advance to leadership in which the increase in organized knowledge and the application of that knowledge are greatest. For this reason, interest in research should be as wide as the nation and should cover the whole gamut of problems from administration to agriculture, from medicine to manufacture. For it is only through the solution of individual problems that general principles can be arrived at and the sum total of useful organized knowledge increased.

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[1] Abstract of an address given April 9, 1917, to the Associated Engineering Societies of Worcester.

It is essential that the wide field to be covered be kept in mind, extending over not only physics, chemistry, engineering and all their branches, but all the biological and mental sciences as well. In the last analysis an increase in knowledge in the field of the *biological sciences* means more and better food, improved racial stock and improved public health as well as increased material welfare in all having to do with plants and animals. Increased knowledge of the fundamental principles of the *mental sciences* means increased efficiency in administration, legislation, education, operation and research. I do not mean mere book learning in psychology, but such a command of the fundamental principles as will assist in the solution of all practical problems. Increased knowledge of *chemistry* means increased ability to utilize raw materials and an improvement in general health and living conditions. One may almost say that the generalized problem of chemistry is to convert the less expensive raw materials such as cellulose, petroleum, glucose, various minerals and oils, starch, nitrogen of the air and the like into food, clothing, tools for our use and means for national defense. An application of the fundamental principles of *physics* in the way of various engineering problems leads to a fuller utilization of resources, new products useful to man, makes inventions possible and effective and adds to the general increase in operating efficiency in every way.

The utilization of organized knowledge in national welfare comes about both through knowledge itself and the incentive to apply that knowledge. Both ability and incentive are essential to utilization. So far as knowledge went, we might have made dyes and optical glass many years ago in this country, but since they could be bought so cheaply there was no incentive to develop the manufacture of such articles. These are cases of ability without incentive. On the other hand, there has long been an incentive for the fixation of nitrogen and for various mechanical devices, but these have not been forthcoming for lack of sufficient knowledge.

The incentive to do our best, to live up to our possibilities as a nation or as individuals may be classed as either psychic or commercial. In the last analysis, the tendency towards doing our best is hardly more than a rudimentary instinct. The commercial incentive is a matter of either supplying our direct needs or supplying some one else's needs for a consideration. The psychic incentives to put forth our best efforts may be classed under the heads of emulation, contact, contract and struggle for existence. A great many students enter research because their favorite professors have made reputations in research or because their friends and colleagues are doing such work. Incentive by *contact* covers the psychology of getting started at the line of work you wish to become interested in. It is well known that the work itself produces a reaction on one's mind which makes it much easier to continue the work. Exactly, this form of stimulus is experienced in writing a scientific paper, for example. Incentive by *contract* to put forth our best efforts comes from putting ourselves under obligation to produce certain results. The substance of this lecture has been in my mind for many years, but it would never have been prepared but for my having undertaken to talk on this subject. This is a typical example of polarization by contract. Finally, the incentive of stern necessity or what we consider necessity is perhaps the most powerful of all in both research and application. All who have families to support and needs to be supplied know full well the stimulus which comes from them.

In general, in normal times it is perhaps no exaggeration to say that neither the average individual nor the average nation approaches within fifty per cent. of its possibilities. Nothing short of a war threatening the national existence can shake a nation out of its lethargy. Similarly, the average individual can not be induced to put forth his best efforts without the strongest of incentives. It is unfortunate that this is the case. However, with sufficient attention given to the problem by trained experts in mental science, it is quite possible that at some future date as high as sixty or eighty per cent. of the possribilites may be realized without any appeal to arms for the nation or any unusual incentive for the individual.

II. *The Increase of Organized Knowledge.*—The research by which organized knowledge is increased will doubtless always be carried on chiefly by three distinct types of research organizations: research by the government in national laboratories, research by the universities in connection with the work of instruction and research by industrial laboratories in connection with the interests of manufacturing concerns. Aside from these three main classes of laboratories there will always be large, privately endowed research organizations, dealing with neglected fields of remote commercial interest, private industrial laboratories supported by consulting fees and cooperative testing laboratories also self sustaining.

National, industrial and university research follow three essentially different lines. There is considerable overlap in field, it is true, but each is centered on a different kind of research. The proper function of national research is the solution of such problems as concern the nation as a whole, affect the general interests of all classes of individuals; it is the custodian of standards, it develops methods of precise measurements and investigation, it is trouble engineer for the solution of very difficult problems or the problems of producing units so small as not to be able to have their own research laboratories. It is the proper guardian of the public health. It solves problems connected with contagious and vocational diseases. It develops methods of making good roads, increasing the fertility of the soil and stocking waters with fish. National research is of all grades from that dealing with fundamental principles up to that relating merely to lessening the costs of production.

University research must always, in the very nature of things, be concerned chiefly with the advancement of the various sciences as such, and with the development of the fundamental principles of each science. The best university instruction is along these lines and investigators and students in close touch with them will naturally have most new ideas in close connection with fundamental principles. University research is necessarily one of small jobs and the best minds and is without very much continuity. The advanced student is interested in a research just long enough to make it acceptable as a doctor's thesis. The instructor is too burdened with teaching to give more than a margin of time to research. But a very small part of the university research is extended year after year covering a wide field. This is quite as it should be, the university looking after those fields of research of little commercial value, on the one hand, and not directly affecting the interests of the nation as a whole, on the other, but of fundamental and far reaching importance to all.

Industrial research takes the middle ground and has already become a distinct profession. It is in close touch with practical commercial application, on the one hand, and with fundamental principles, on the other. Its proper field is anything between elimination of works troubles and the investigation of fundamental principles. The staff of the ideal industrial research laboratory is composed of experts of wide experience who can serve the manufacturing departments in a consulting capacity without sacrifice of time. We may perhaps best summarize the preceding statements by describing the ideal research man and the ideal research laboratory.

Some writers have spoken of the investigator as a rare individual to be sifted out from educational institutions with great care for a particular line of work. My personal opinion is that a large percentage of the men students are fitted for research work if properly started along the right line. The investigator should have a mind at once fertile and well trained. His mind should be teeming with new ideas, but he should possess unerring judgment to reject those which are not logical or promising. We are often asked what sort of preparation in physics would be best for men intending to take up research as a life work. It has even been proposed to give courses in "applied physics" for the benefit of those intending to take up industrial research. Our invariable reply is that the best preparation for a research man is a thorough grounding in the fundamental principles of his science: physics, chemistry or whatever it may be. If he has this thorough knowledge of fundamental principles it is safe to say that in any properly organized research laboratory with the proper leadership and companions, such a student will have many times as many useful ideas as he can himself possibly follow up with research. Hardly any one who has completed advanced work in a science can read, say an abstract journal, without thinking of many problems which he would like to investigate. Fertility of mind is not so much an inborn quality of the mind itself as of the training and association which that mind has had.

The ideal industrial research organization may perhaps be outlined with a knowledge of its development during the last fifteen years. I shall give, frankly, my personal views in the matter, based on an intimate knowledge of four universities, three professional research laboratories and a visiting acquaintance, so to speak, with quite a number of others. The ideal industrial laboratory, in my mind, consists of two quite distinct divisions: one taking the brunt of works troubles and testing or making analyses of the material used. The other wing is complementary to this and deals with the larger fundamental problems encountered, problems requiring skilled specialists and considerable time for their solution. The alternative organization with a single research laboratory covering both works troubles and fundamental problems is not so successful. The plan in this case is to have considerable research in progress of very little interest to the company, but engaging a staff much larger than required to take care of ordinary works troubles. In this case, when works troubles are many and insistent, as they are wont to be at times, the staff engaged upon fundamental research forms a reserve to be called out occasionally to deal with works troubles. The disadvantages of this are that the fundamental work is subject to more or less frequent interruption and can not be so efficiently carried on. On the other hand, when the research is in two quite distinct divisions, fundamental work is not subject to interruption by works troubles.

Industrial research is preeminently fitted to be carried on by team work. This we have developed to a high degree in Pittsburgh and consider very much more efficient than the alternative cell system where each leading man has a room or suite of rooms to himself and keeps his work to himself. In the ideal organization, two or three men work together on the same large problem or group of problems, the aim being to have a good theoretical man and a good experimentalist working together as much as possible or even a physicist and chemist in some cases. The characteristic of the team work plan, however, is the conference system. The five or six men most interested in each line of research meet for an hour each week to discuss the problem in its various aspects, to plan new work and to consider various interpretations and applications of the results obtained. The ideal conference is not less than four and not more than eight men and includes an efficient stenographer. To one experienced in such team work, the results of getting together are surprising. A good suggestion is no sooner made than capped by a better and the saving in time and effort is almost incalculable.

The conference system also aids in putting useful results before the other wing of the research division and before the patent department. At each of our conferences are representatives of the other wing of the research division, charged with taking up any results immediately applicable, and a member of the legal department who takes care of any ideas worth patenting. This plan of conferences relieves the scientific men from responsibility for calling the attention of the works or of the patent department to useful patentable results.

So far as national welfare is concerned, in order to increase our stock of organized knowledge, we need more teaching by professors and instructors in closer touch with industrial problems. So far as developing research men goes, the ideal instructor is probably an ex-professional research man and, in many cases, one who has made a reputation or a fortune by his work along industrial lines. Another need is, of course, more research laboratories all along the line. The increase would naturally be among industrial organizations and the expense borne largely by manufacturing concerns, since it is they who reap the chief direct financial benefit.

Another great need is cooperation among the various branches of research: university, national and industrial. There should be a free interchange of men between such laboratories, and each should be thoroughly familiar with the needs and problems of the other. One great benefit from this war, if it lasts sufficiently long, will be to force cooperation between different branches of research.

III. *The Application of Organized Knowledge.*—The present national crisis brings home to us the crying needs of the nation in availing itself of the knowledge and ability at its command. Fifty thousand specialists in applying scientific knowledge to practical problems as well as scores of research laboratories have offered their services to the nation. But problems requiring investigation are slow in being developed. Once they are formulated and given to the engineers of the country, few will remain unsolved very long.

It is for the engineer to apply the results of research to practical problems and to carry practical problems demanding general research back to the research laboratories. To the engineer, every special problem requires a special application of fundamental principles. Is it too much to hope that the day is rapidly approaching when all great problems, particularly those of our national and state governments, will be automatically placed in the hands of trained specialists? Not self-seeking politicians, nor yet men with mere theories, but engineers with a real command of fundamental principles, men with an unbroken record of big achievements and no failures, men ever ready to stake their all on their ability to handle problems in their specialty.

Professor Joseph Le Conte, in an address years ago, remarked that each of the great professions first attained high standing when it was taught as such in universities. When so taught, the professional men turned out are no longer quacks, but each has a real command of the fundamental principles in his chosen field of action. The basic relation is that any profession has standing in so far as its fundamental principles have been developed and applied. To retain standing, a profession must be continually increasing its stock of knowledge of fundamental principles through research. The engineer of standing in his profession must not be content with a mere working knowledge of rules of thumb, but must have a real command of basic principles in his chosen field and in related fields. The illuminating engineer, for example, should know not only lighting, but should possess a working knowledge of the laws of vision and of geometrical and physical optics. So the great physician or construction engineer has a command of his own field and an intimate acquaintance with related fields.

So also with research as a profession, the leaders have not only a taste for research and logical minds to clearly analyze and attack problems with thorough scientific knowledge, but have a knowledge of the principles of research; getting the most out of their own minds, avoiding side issues, cooperating with their colleageus and putting their most valuable results in permanent, readily available form. Research is one of the youngest of the professions and one with a promising future, but let no one enter it without thorough knowledge or a full understanding of its aims and methods. With sufficient attention given to research and to its application, this nation with its great national resources should at once attain and retain a permanent lead among the nations of the earth.

P. G. NUTTING

THE PROOF OF MICROBIAL AGENCY IN THE CHEMICAL TRANSFORMATIONS OF SOIL

EVERY now and then in the development of a science it is well to stop and consider how many of the current statements are based on established fact and how many have arisen from assumptions repeated so often that they have come to be generally believed. Certain common statements in regard to the bacteriology of soil may well bear such scrutiny. Has it, for instance, been definitely proved that any particular microorganisms cause any of the well-known biological activities in soil? This question is quite pertinent at present because of statements frequently found in the literature that certain bacteria or groups of bacteria are responsible for certain chemical transformations in soil, although complete proof of the causal relation has never been obtained.

The cause of these loose statements is easy to understand when it is considered that it is practically impossible to obtain direct evidence as to what actually goes on within the soil. Laboratory experiments show what the microorganisms do under laboratory conditions, but not what they do in the soil. Even though the activity of an organism be tested in soil itself, its true activity in the field may still remain unknown, because such laboratory tests have to be carried out in pure culture, and pure cultures do not occur in the field. The activities of bacteria in soil are associative actions; and an organism capable of vigorous activity in pure culture may be almost inactive in the presence of its natural rivals. Laboratory tests, therefore, give but indirect evidence at their best. Indirect evidence has its value; but it is futile to draw conclusions from it unless results obtained by one method are confirmed by those obtained in some other way.

Similar difficulties in regard to pathogenic bacteria caused the literature of the early nineteenth century to abound in misstatements as to the relation of certain bacteria to certain diseases. Gradually, however, it came to be recognized that neither the constant presence of a given microorganism in a certain disease, nor its ability to produce a similar disease in lower animals proves it to be the causal agent of a human disease. These ideas were put in concise form by Koch when he restated and emphasized the requirements originally suggested by Henle as necessary steps in proving a given organism to be the cause of a given disease. These postulates, as stated by Koch, are as follows: (1) The organism must be shown to be present in abundance in the tissues, blood, or discharges of animals suffering from the disease; (2) it must be isolated and studied in pure culture; (3) it must be shown capable of producing the same disease in healthy animals; (4) it must subsequently be found again in abundance in the experimentally inoculated animals.

Really the case of bacterial activities in soil is analogous. The constant presence of a certain organism in manured soil, for instance, does not prove that it decomposes the manure any more than the constant presence of an organism in a given disease proves its causal relation. Neither does the fact that an organism ammonifies laboratory media prove that it ammonifies organic matter in soil, any more than the fact that an organism produces a certain disease in a lower animal proves that it produces a similar disease in man. Although this fact may be recognized in a general way by soil bacteriologists, a little thought will show that no rules as strict as Koch's postulates have ever been followed in establishing the agency of bacteria in any soil activity—with the exception of the bacteria of legume nodules. Even in regard to the nitrifiers—certain as we may be of their agency in converting ammonium salts into nitrates—we do not have the complete proof. This thought is somewhat disconcerting and shows the need of drawing up strict rules to apply to the activities of soil microorganisms. Koch's postulates can not be applied directly to soil microorganisms, because the latter operate under quite different conditions from pathogenic bacteria; but it is possible to modify his rules to fit soil conditions.

The first postulate is that the organism must be shown to be present in abundance in animals suffering from the disease in question. It is equally necessary to show that an organism is present in abundance in soil in which a certain biological activity is going on—in fact that it is more abundant in such soil than in similar soil in which the activity is not taking place—before asserting that the organism in question is the causal agent. It is also necessary to show that the organism is present in such soil in *active* form. This is necessary because at least three groups of soil microorganisms have inactive as well as active forms: namely, protozoa, molds and spore-bearing bacteria. If the organism in question belongs to one of these three groups, the mere demonstration of its presence is not enough, but it must be shown to be present in active form. In other words, Koch's first postulate must be expanded as follows when applied to soil conditions: The organism in question must be shown to be present in active form when the chemical transformation under investigation is taking place; and must also be shown to be present in larger numbers in such soil than in similar soil in which the chemical change is not taking place. These two steps have seldom been carried out in investigating the cause of any biological activity in soil, but they are nevertheless as important as Koch's first postulate in regard to pathogenic bacteria. They are perhaps a little more stringent than the first postulate of Koch's; but special stringency is necessary here in view of the difficulty in applying Koch's last two postulates to soil conditions.

The second postulate of Koch's is that the organism be isolated and cultivated in pure culture. This can be applied without modification to soil conditions, and indeed is generally carried out by soil investigators.

The third postulate is that the organism be shown capable of producing the same disease in healthy animals. The corresponding requirement in regard to soil bacteria is extremely difficult to meet. It is possible to inoculate the organism in question into sterile soil and study its activity under such conditions—a test which is quite commonly made. Such a test, however, does not furnish conclusive proof. Sterilized soil is always different from natural soil; but worse still, activities in pure culture may be very different from activities in mixed culture. To obtain complete proof, the organism in question should be inoculated into unsterilized soil, and then if the activity under investigation occurs the organism should be shown to be present in large numbers. Such a procedure, however, is generally impossible, because of the difficulty of getting an organism to grow vigorously in soil already stocked with a bacterial flora of its own; and the interpretation of results is difficult, because—in distinct contrast to the specific agency of microorganisms in disease—the same chemical transformation in soil may be caused by distinctly different organisms. For this reason the best that can ordinarily be done is to inoculate the organism in question into sterilized soil. To do so furnishes better proof than to inoculate it into any laboratory medium, but the unsatisfactory nature of the test must be fully recognized. Perhaps it is not overstating the case to say that much of the past confusion in regard to the activities of soil bacteria has arisen from the fact that they have been studied in pure culture while pure cultures never occur naturally in soil. The inoculation of sterilized soil is ordinarily the only practical course, however, and has its value as a means of confirming the tests carried out in connection with the requirements already mentioned.

Koch's last postulate is that the organism be found in the tissues, blood or discharges of the experimentally inoculated animals. The corresponding requirement in regard to soil activities is superfluous, provided sterile soil is used for inoculation and contamination is prevented during the experiment. If unsterilized soil is used, the presence of the organism in question should be demonstrated; but the impractibility of using unsterilized soil makes this last requirement of little value as applied to soil conditions.

Summing up, it may be said that to show conclusively the agency of any microorganism in any chemical transformation occurring in soil, the following steps are necessary: (1) The organism must be shown to be present in active form when the chemical transformation under investigation is taking place; (2) it must be shown to occur in larger numbers under such conditions than in the same soil in which the chemical change is not occurring; (3) it must be isolated from the soil and studied in pure culture; (4) the same chemical change must be produced by the organism in experimentally inoculated soil, making the test, if possible, in unsterilized soil. The fourth reqiurement, however, can ordinarily be carried out only by inoculating sterilized soil, a procedure which does not give rigid proof, but which is fairly conclusive if carried out in connection with the other three requirements.

Sometimes these facts can be brought out wholly by cultural methods, such as used in the past. It must be remembered, however, that cultural methods, at their best, are open to serious error, as organisms that are naturally inactive may become active under cultural conditions, while under similar conditions naturally active organisms may lose their activity. This fact will make it necessary to check up cultural methods with methods of other sorts. Possibly the use of the microscope[1] will help solve some of the problems, or perhaps methods of an entirely new sort will be needed. At all events, more attention must be given to the steps involved in proving the causal relation of definite microorganisms to definite biological activities in the soil in order to avoid making loose statements in regard to the functions of these organisms, such as have often been made in the past.

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[1] See Conn, H. J., 1917, "The Direct Microscopic Examination of Bacteria in Soil." (Paper presented at New Haven meeting of the Society of American Bacteriologists.) Abstract in "Abstracts of Bact.," Vol. 1, p. 40.

H. Joel Conn

N. Y. Agricultural Experiment Station,
Geneva, N. Y.,
July 25, 1917

THE FIRST PUEBLO RUIN IN COLORADO MENTIONED IN SPANISH DOCUMENTS

There is in the Congressional Library, among the documents collected by Peter Force, a manuscript diary of early exploration in New Mexico, Colorado, and Utah, dated 1776, written by two Catholic priests, Father Silvester Velez Escalante and Father Francisco Atanacio Dominguez. This diary is valuable to students of archeology, as it contains the first reference to a prehistoric ruin in the confines of the present state of Colorado, although the mention is too brief for positive identification of the ruin.[2] While the context indicates its approximate site, there are at this place at least two large ruins, either of which might be that referred to. I have no doubt which one of these two ruins was indicated by these early explorers, but my interest in this ruin is both archeological and historical. Our knowledge of the structure of these ruins is at the present day almost as imperfect as it was a century and a half ago.

The route followed by the writers of the diary was possibly an Indian pathway, and is now called the old Spanish Trail. After entering Colorado it ran from near the present site of Mancos to the Dolores. On the fourteenth day from Santa Fe, we find the following entry: "En la vanda austral del Vio [Rio] sobre un alto, huvo antiquam (te) una Poblacion pequeña, de la misma forma q^e las de los Indios el Nuevo Mexico, segun manifieran las Ruinas q^e do invento registramos."

By tracing the trip day by day, up to that time, it appears that the ruin referred to by these early fathers was situated somewhere near the bend of the Dolores River, or not far from the present town of Dolores, Colorado. The above quotation indicates that the ruin was a small settlement, and situated on a hill, on the south side of the river or trail, but it did not differ greatly from the ruined settlements of the Indians of New Mexico with which the writers were familiar, and had already described.

A century later, 1876, we find a published reference to a ruin near the bend of the Dolores, which suggests the above mentioned. An exploring expedition of the engineer department of the United States Army from Santa Fé, New Mexico, to the junction of the Grand and Green Rivers of the Great Colorado of the west, under command of Capt. J. M. Macomb, U. S. A., in 1859, followed the old Spanish Trail. Professor J. S. Newberry, of the expedition, in a geological report described a ruin not many miles from the bend of the Dolores: "Surouaro is the name of a ruined town which must have contained a population of several thousands [*sic*]. The same is said to be of Indian (Utah) origin, and to signify desolation, and certainly no better could have been selected. . . . The houses are, many of them, large, and all built of stone, hammer-dressed on the exposed faces. Fragments of pottery are exceedingly common, though, like the buildings, showing great age. The remains of metates (corn mills) are abundant about the ruins. The ruins of several large reservoirs[3] built of masonry may be seen at Surouaro, and there are traces of acequias which led to them through which water was brought perhaps from a great distance."

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[1] Published by permission of the Secretary of the Smithsonian Institution.

[2] Diario y Derectero de las neuvas descubrimientos de tierras á los r'bos N.N.OE.OE. del Nuevo Mexico por los R.R.P.P.Fr. Silvester Vales Escalante, Fr. Francisco Atanacio Domingues, 1776. (*Vide* Sen. Ex. Doc. 33d Congress, No. 78, pt. 3, pp. 119–127.)

[3] Probably kivas, but impossible to identify without excavations. J. W. F.

On several maps, as that accompanying a report of another survey across the continent, by William J. Palmer, published in 1867 and 1868, sites of ruins are indicated in southwestern Colorado. Printed references to Surouaro are made by Jackson, Holmes, Prudden, and other writers, but aside from the statement of the last mentioned, that it is a cluster of mounds indicating pueblos of the unit type, we know little regarding their size and architectural peculiarities. The arrangement of mounds in a cluster, like many others in the cedar clearings, suggests the Mummy Lake group on the Mesa Verde, and it is probable that each member of the group if excavated will be found to resemble Far View House.

My attention was called to a ruin near Dolores by Mr. R. W. Williamson, of that city, and not being able to visit the site I urged him and others to collect more details, from which my belief was confirmed that the ruin mentioned by the Spanish fathers is the same as Newberry's Surouaro.

As one fruit of my inquiries for corroboratory evidences bearing on the identification of the oldest mentioned ruin, I obtained unexpected information from Mr. J. W. Emerson, a ranger on the Montezuma Forest Reserve, who is well acquainted with the region near Dolores. In a letter received a short time ago from Mr. Gordon Parker, supervisor of the reserve, who has always shown great interest in my work at the Mesa Verde, there was enclosed a copy of a report made by Mr. Emerson to the Forest Service, on a remarkable ruin near Dolores which, although not corroborating the above identification, greatly intensified the desire of several years to visit the area in which lies the supposed first ruin in Colorado mentioned in writings by white men. Mr. Emerson's report is accompanied by a rude ground plan, indicating a ruin as unusual in form as the mysterious Sun Temple of the Mesa Verde Park, which it somewhat resembles.

It does not answer the description of Surouaro by Newberry, and its exceptional character would not have impressed the Spanish fathers, if they noticed it at all. In fact, judging from the "ground plan" furnished by Mr. Emerson, its form is remarkable even in a region where many different forms exist.

I will not occupy the reader's time with the details of the building revealed in this report, as they would be more appropriate in a formal article and can be greatly augmented by excavations, but will point out that its form is roughly semicircular, the plan showing concentric walls bounding rooms separated by partitions, the outer straight wall on the south side being like the south wall of Sun Temple. The building measures 100 by 80 feet, exhibiting masonry characteristic of the purest pueblo type. A complete excavation promises to reveal data on the connection between the prehistoric towers of the southwest, circular ruins, and the problematical Sun Temple.

It is evident that the southwestern corner of Colorado, from which locality not a single ruin had been recorded a century and a half ago, contains some of the largest, best constructed, and most mysterious pueblo ruins and cliff dwellings in the United States, and offers unusual data bearing on the history of aboriginal American culture.

J. WALTER FEWKES

BUREAU OF AMERICAN ETHNOLOGY,
SMITHSONIAN INSTITUTION

SCIENTIFIC EVENTS

PRODUCTION OF NITRATES BY THE GOVERNMENT

ANNOUNCEMENT is made by the War Department of its preparations for the production of nitrates in accordance with a report filed by the Nitrate Supply Committee. This report is given in part below. It is further stated that for the present the location of the proposed nitrate plant is withheld, but information concerning its location will be given as soon as a definite decision is reached. The work of supplying the machinery and materials needed for the plant has begun.

The Nitrate Supply Committee, appointed by the Secretary of War, was under authority of a provision in the national defense act for an investigation "to determine the best, cheapest and most available means for the production of nitrates and other products for munitions of war and useful in the manufacture of fertilizers and other products."

The general recommendations and report of the Nitrate Supply Committee are announced as follows:

After a deliberate and careful consideration of all the matter and information at the disposal of the committee, it submits the following as its action:

1. The committee, appreciating the offer of the General Chemical Company, recommends that the government enter into negotiations to acquire the rights to use the synthetic ammonia process of that company.

2. That contingent upon satisfactory arrangements with the General Chemical Company, out of the $20,000,000 nitrate supply appropriation such sum as may be needed, now estimated at $3,000,000, be placed at the disposal of the War Department to be used in building a synthetic ammonia plant, employing the said process of the General Chemical Company, and of a capacity of 60,000 pounds of ammonia per twenty-four-hour day, said plant to be located in a region where land, water, coal and sulphuric acid are cheaply available, where good transportation facilities exist, and where the proposed new powder plant of the government can be properly located. In the opinion of this committee all of these conditions just enumerated are best fulfilled by a location in southwest Virginia or contiguous region.

3. That out of the $20,000,000 nitrate supply appropriation an amount now estimated at $600,000, or as much as may be needed, be placed at the disposal of the War Department to be used in building a plant for the oxidation of ammonia to nitric acid and the concentration of nitric acid, of a capacity equivalent to 24,000 pounds of 100 per cent. nitric acid in a twenty-four-hour day, said plant to be located in the neighborhood of the aforesaid synthetic ammonia plant and the proposed new powder plant of the government.

4. That the War Department proceed at the earliest practical date with the construction of the oxidation plant and contingent upon a satisfactory arrangement with the General Chemical Company, also with the synthetic ammonia plant, and that the government give such priority orders as will secure from contractors prompt delivery of the materials and rapid construction of the structure and machinery needed for those plants.

5. The committee, appreciating the offer of the Nitrogen Products Company granting, in this country, to the government, under certain conditions, the right to use the so-called Bucher process for the production of sodium cyanide and ammonia, recommends that a form of contract, drawn with the advice of the legal authorities of the government, such as to give that company no guaranty or exclusive rights in the process, or in its future development, beyond those which the company's own patents give to it, be entered into with the Nitrogen Products Company, and that experimentation looking toward the industrial development of the Bucher process for the production of ammonia be at once proceeded with. And, further, that contingent upon a satisfactory arrangement with the Nitrogen Products Company, a sum not to exceed $200,000 be allotted for this purpose out of the $20,000,000 nitrate supply appropriation.

6. That out of the $20,000,000 nitrate supply appropriation $100,000 be made available for the active prosecution of investigations of processes for the industrial production of nitrogen compounds useful in the manufacture of explosives or of fertilizers, and that these investigations be planned and supervised by the War Department.

7. That in order to increase the production of ammonia and toluol the government promote the installation of by-product coke ovens by directing that priority be given in the production, delivery, and transportation of the materials and parts needed in their construction.

8. That the decision as to more extensive installation of nitrogen fixation processes and water power development in connection with them be postponed until the plants above rec-

ommended are in operation or until further need arises.

9. While the preceding recommendations include all the measures that can now judiciously be taken for the fixation of nitrogen and the oxidation of ammonia, it is the opinion of the committee that the immediate accumulation and the permanent maintenance of an ample reserve, not less than 500,000 tons of Chile saltpeter, is the measure most urgently necessary.

The Nitrate Supply Committee comprised the following Army and Navy officers, scientific men and engineers:

Brig. Gen. William Crozier, Chief of Ordnance, War Department; Rear Admiral Ralph Earle, Chief of the Bureau of Ordnance, Navy Department; Brig. Gen. William M. Black, Chief of Engineers U. S. A.; F. W. Brown, Bureau of Soils, Department of Agriculture; Leo H. Baekeland, Yonkers, N. Y.; Gano Dunn, New York City; Charles H. Herty, New York City; William F. Hillebrand, Bureau of Standards, Department of Commerce; Arthur A. Noyes, Institute of Technology, Boston, Mass.; Charles L. Parsons, Bureau of Mines, Interior Department; and Willis R. Whitney, Schenectady, N. Y.

THE ARMY AVIATION SCHOOL AT THE UNIVERSITY OF CALIFORNIA

In the United States Army School of Military Aeronautics at the University of California the following appointments have been made:

Major Arnold N. Krogstad, J.M.A., Signal Corps, commandant, quartermaster, ordnance officer, summary court, president of examining board.

Dr. B. M. Woods, president of academic board.

First Lieutenant Bruno F. Sandow, Medical Reserve Corps, post surgeon, member of examining board.

First Lieutenant Gerald F. Stoodly, Dental Reserve Corps, dental surgeon.

M. S. E. Herman H. Walker, Signal Corps, retired, clerk, commandant's office.

M. S. E. Milton N. Williams, Signal Corps, retired, acting quartermaster sergeant.

Private Joseph L. Walker, A.S., Signal Corps, assistant instructor in rigging.

Professor B. F. Raber, associate professor of mechanical engineering and professor of aeronautical engines.

D. J. Conant, professor of aeronautical engines.

Donald B. McFarlane, instructor in gas-engine practise.

F. H. Bachman, instructor in internal-combustion engines.

Collier Raber, mechanic and tool-room keeper.

J. A. Polhemus, instructor in theoretical mechanics.

H. M. Jeffers, instructor in astronomy and meteorology.

W. D. Waterman, instructor in rigging, structure and care of aeroplane.

R. J. Heffner, instructor in maps and reconnaissance.

E. N. D'Oyly, instructor in artillery observation and use of miniature artillery range.

Dr. L. T. Jones, instructor in physics and professor of machine guns.

F. S. Stockton, G. R. McDonald and Herbert G. Russell, instructors in machine guns.

R B. McPhorson, instructor in wireless and signaling.

Harold Fielder, instructor in wireless.

E. S. Pillsbury and E. F. Steen, instructors in military tactics and lecturers.

Clifton R. Gordon, J. C. Moses and G. G. Mitchell, instructors in military tactics.

F. W. Cozens, instructor in physical education.

Grandison Gardner, instructor.

APPOINTMENTS IN THE ORDNANCE DEPARTMENT OF THE ARMY

The United States Civil Service Commission announces the following open competitive examinations for positions in the several ordnance establishments of the War Department or in or under the office of the Chief of Ordnance, War Department, Washington, D. C. The salaries named are for entrance.

Mechanical engineer, artillery ammunition, $3,000 to $3,600 a year.

Mechanical engineer, experimental work, $2,500 to $3,000 a year.

Mechanical draftsman, $1,000 to $1,400 a year.

Apprentice draftsman, $480 a year.

Inspector of artillery ammunition, $1,500 to $2,400 a year.

Inspector of field artillery ammunition steel, $1,500 to $2,400 a year.

Assistant inspector of field artillery ammunition steel, $3.50 to $5 a day.

Inspector of ammunition packing boxes $3.52 a day to $1,800 year.
Inspector and assistant inspector of powder and explosives, $1,400 to $2,400 a year.
Inspector of ordnance equipment, $1,500 to $2,400 a year.
Assistant inspector of cloth equipment, $80 to $125 a month.
Assistant inspector of leather, $100 to $125 a month.
Assistant inspector of small hardware, $80 to $125 a month.
Assistant inspector of textiles, $80 to $125 a month.
Assistant inspector of leather equipment, $100 to $125 a month.
Clerk qualified in business administration, $1,200 to $1,500 a year.
Index and catalogue clerk, $1,000 to $1,200 a year.

The examination for index and catalogue clerk is open to both men and women; the other examinations are open only to men.

The president of the commission writes that the government urgently needs men for the work above indicated, and qualified persons are urged, as a patriotic duty, to apply for examination. Until further notice applications for the positions named will be received at any time by the United States Civil Service Commission, Washington, D. C. Papers will be rated promptly. Applicants will not be required to appear at any place for examination, but will be rated principally upon the elements of education, training and experience, as shown by their applications and by corroborative evidence.

Full information concerning examinations, application blanks, etc., may be obtained by calling in person upon the secretary of the local board of civil service examiners at the post office in any city in which city delivery of mail has been established, or by communicating with the United States Civil Service Commission, Washington, D. C.

SCIENTIFIC NOTES AND NEWS

Sir Clifford Allbutt has been continued in the office of president of the British Medical Association for the coming year. It is hoped that a meeting will be held at Cambridge next year.

Professors Golgi, Novaro and Roster, having reached the age of seventy-five years, automatically retired from their chairs in Italian universities. Professors Golgi and Novaro are both senators of the realm. The former is professor of general pathology at Pavia, and Novaro of surgery at Genoa. Roster is professor of hygiene at Florence.

The Secretary of War announces the appointment of the following to investigate the matter of defective ammunition sent to the American expeditionary force in France: Dr. H. P. Talbot, professor of chemistry at the Massachusetts Institute of Technology; Dr. C. L. Parsons, chief chemist of the Bureau of Mines; an army officer to be named by Major General Hugh L. Scott, Chief of Staff.

The United States Food Administration announces that Professor H. A. Morgan, of Knoxville, Tenn., has been appointed federal food administrator for Tennessee.

Dr. Arthur M. Shipley, of Baltimore, professor of surgery at the University of Maryland, who had received his commission as chief of the surgical staff of the University of Maryland Base Hospital Unit, has been detached from the unit by order of the War Department, and ordered to report immediately to Camp Meade as chief surgeon and surgical instructor at the camp.

E. N Wentworth, professor of animal breeding at the Kansas State Agricultural College, has received a commission of captain in field artillery. For the present he will be stationed at Fort Riley.

Robert A. Patterson, Ph.D., instructor in physics in Yale College, has been commissioned captain in the field artillery section of the Reserve Officers' Corps, and assigned to the camp at Ayer, Mass.

Dr. Leon I. Shaw, of the department of chemistry of Northwestern University, has been advanced to the position of assistant professor of chemistry on leave of absence for one year for service with the government. He has received the appointment of first lieutenant in the Ordnance Officers' Reserve Corps.

D. W. Blakeslee, electrical engineer and assistant superintendent, Penn Electrical and Manufacturing Co., Irwin, Pa., has been ordered to report at Washington for active duty as first lieutenant in the Engineer Section, Officers' Reserve Corps, United States Army.

Dr. Edward G. Birge, director of the State Bacteriological Laboratory, Jacksonville, Florida, has been given an indefinite leave of absence by the Florida State Board of Health. Dr. Birge has received a commission as captain with the Medical Reserve Corps of the United States army.

The *Journal* of the American Medical Association states that Dr. Charles Wardell Stiles, U. S. Public Health Service, has discovered forty-seven cases of hookworm in seventy-five recruits mobilized for war service, and these findings have caused the United States Public Health Service to recommend the prompt examination for hookworm of all units of the national guard and national army, especially those from the south.

Surgeon French Simpson, U. S. Public Health Service, has been ordered to Columbia, S. C., to take charge of the campaign against malaria.

Dr. B. Frank Knause, of Brooklyn, N. Y., has been appointed deputy commissioner and sanitary superintendent at a salary of $6,000 a year. The appointment is also announced of Dr. Herman Tapley Peck, also of Brooklyn, as assistant sanitary superintendent at $5,500 a year.

E. W. Jahnke has been appointed superintendent of the state grain and seed laboratory at Bozeman in connection with the State College of Montana, to succeed B. Whitlock, who resigned to accept a position with the federal department of agriculture in the administration of the grain standardization act. Mr. Whitlock will have his headquarters at Salt Lake, and will superintend the administration of the law over a large part of the northwest. Mr. Jahnke who becomes superintendent at Bozeman has been an assistant to Mr. Whitlock for the past two years.

Mr. Arthur T. Bolton has been appointed curator of Sir John Soane's Museum, Lincoln's Inn Fields, in succession to the late Mr. W. L. Spiers.

A Reuter despatch to the daily papers states that Professor Kenzo Futaki claims to have discovered, after three years' original research work in the Japanese Imperial Government Laboratory, the specific cause of typhus fever. He calls this new germ the *Spirochæte exanthematotyphis*.

Dr Colin G. Fink, for the past ten years in the Research Laboratories of the General Electric Company, has been appointed head of the new Chile Exploration Company laboratories, located at 202d Street and 10th Ave., New York City. The work in the new laboratories will be largely research along metallurgical and electrochemical lines.

Dr. L. F. Nickell, formerly assistant professor of chemistry at Washington University, has resigned to become chemist in the research department of the Monsanto Chemical Works in St. Louis.

Dr. Charles K. Francis, for the past seven years chemist and professor of petroleum technology in the Oklahoma Agricultural and Mechanical College, has resigned to become chief chemist for the Cosden Oil Company, Tulsa, Okla.

Professor Francis Ramaley, who has been making vegetation studies in California since February, has returned to his work at the University of Colorado.

Professor C. E. Clewell, of the University of Pennsylvania, delivered on September 10 his fourth annual lecture on the fundamental principles of natural and artificial factory lighting before the junior students in electrical and mechanical engineering in the summer term of mechanical technology at the Sheffield Scientific School of Yale University.

The death is announced of Major-General T. Rosati, surgeon-general of the Italian navy, at the age of fifty-seven years. He was formerly professor of ear and throat diseases at the University of Naples.

DR. ELIOT R. CLARK, professor of anatomy in the University of Missouri, recently delivered an address on "Some aspects of the problem of endothelium," and Dr. Frederick G. Novy, professor of bacteriology in the University of Michigan, an address on "Anaphylaxis" before the faculty and students of the graduate summer quarter in medicine of the University of Illinois.

THE Cavendish lecture of the West London Medico-Chirurgical Society was delivered by Captain Andrew Macphail, Canadian Army Medical Corps, who is professor of the history of medicine at McGill University, Montreal, who took as his subject "A Day's Work."

A NEW pedestal for the bust of John Muir, naturalist and explorer, is now being made at the University of Wisconsin to be placed in the Building for Biology, where the bust of Muir now stands. The pedestal will bear this inscription:

JOHN MUIR, 1838–1913
AUTHOR, EXPLORER, NATURALIST
A PRIEST AT NATURE'S SHRINE.

CHARLES HOWARD PARMLY, professor of physics of the College of the City of New York, died at Ashland, N. H., from cerebral hemorrhage on September 8, aged forty-nine years.

DR. G. STANCULEANU, professor of ophthalmology at the University of Bucharest until the German invasion, who has been lecturing in this country in the interest of the Roumanian government, died recently of pneumonia at a sanatorium at Stamford, Conn.

THE death is announced of Dr. Charles Mongour, professor of internal pathology and medical jurisprudence at the Bordeaux Medical School.

IT is stated in *Nature* that the mycological collection of the late Dr. J. W. Ellis has been acquired by purchase by the herbarium at Kew. It comprises nearly 1,600 dried specimens, is especially rich in micro-fungi, and includes a series of mounted specimens of those of economic importance. There are also 330 microscopic slides.

UNIVERSITY AND EDUCATIONAL NEWS

As a war measure a limited number of women may be admitted this year to the courses of the Harvard Medical School. They will not receive or be eligible to receive the university degree. Formal action has not been taken by the corporation, but tentative arrangements are being made and will probably become effective by the time college opens for the new session.

THE department of forestry of the University of Idaho has recently been segregated from the College of Arts and Science as an independent school Professor F. G. Miller, formerly head of the department of forestry at Washington State College, has been elected dean of the school, and professor of forestry.

DR. HENRY KRAEMER, for twenty years professor of botany and pharmacognosy at the Philadelphia College of Pharmacy, will succeed the late Dr. Julius O. Schlotterbeck as professor of pharmacognosy of the college of pharmacy of the University of Michigan.

ALMON H. FULLER, dean of the school of engineering at the University of Washington, Seattle, has accepted the appointment to the head of the department of civil engineering at Lafayette College to succeed Professor J. Madison Porter. Donald B. Prentice, of the Sheffield Scientific School, Yale University, has been appointed assistant professor of mechanical engineering. He will take charge of the work in boilers and heat engineering hitherto cared for by Professor Fitch.

DR. H. B. SHAW, former dean of the School of Engineering of the University of Missouri, has been appointed supervisor of the Doherty cadet school Dr. Shaw's duties will include the selection of men from the universities of the country to become Doherty cadets, to supervise the courses and to recommend cadets for regular posts in the organization. He will make his headquarters, it is expected, in Toledo, Ohio.

Dr. Truman Lee Kelley, of the University of Texas, has been elected assistant professor of education at Teachers College, Columbia University. Dr. Kelley is to devote a large part of his time to research on psychological measurements in secondary education.

Northwestern Uiversity Medical School announces the following faculty appointments for 1917–1918: Drs. Frederick G. Harris, professor of dermatology and syphilology, succeeding Professor Joseph Zeisler, who becomes professor emeritus of dermatology; Frank C. Becht, professor of pharmacology, succeeding Professor Hugh McGuigan; John Ridlon, honorary professor of orthopedic surgery; John L. Porter, professor of orthopedic surgery; Herbert A. Potts, professor of oral surgery; Frank E. Simpson, adjunct clinical professor of dermatology; Charles P. Caldwell, adjunct clinical professor of medicine; Edward L. Moorhead, adjunct clinical professor of surgery.

DISCUSSION AND CORRESPONDENCE

TESTS OF RADIATOR HUMIDIFIERS

By request of physicians I have tested four types of radiator humidifiers on the market in Minneapolis. The experiments were performed at my house, which is heated by hot water. For the first three types mentioned the tests were made at the same time on the same radiator. The results are therefore strictly comparable. The results for the "Flobun" were obtained at a later date. All results have been calculated to indicate evaporation, per twenty-four hours, for each horizontal foot of radiator occupied by the apparatus.

RESULTS

"Speco," av. of 3 tests, zero weather, January, 1916	294 g.
"Savo," av. of 3 tests, zero weather, January, 1916	230 g.
"Buddington," av. 3 tests, zero weather, January, 1916	1,116 g.
"Flobun," av. of 2 tests, zero weather, December, 1916	1,248 g.

These results for the "Buddington" and "Flobun" were obtained using wicks which were new or nearly new. But the efficiency of both instruments rapidly falls if tap water is used, owing to clogging of the wicks. In two days the loss of efficiency in one series of experiments with the "Flobun" was 25 per cent.

Inasmuch as 10 to 30 gallons of water (Bryce, of Ottawa, says 75 gallons) must be evaporated daily in an ordinary-sized house to maintain reasonable humidity under the conditions of our northern winters, it will be seen that these radiator devices are practically worthless. Using the sling psychrometer I was never able to detect an increase of humidity from the use of any of them. Indeed, the best of them is no more efficient as an air moistener than one human being. The average evaporation from lungs and skin of a large laboratory class in subzero weather, and about 70° inside temperature, was nearly two ounces per hour per person, or about 1,200 grams a day.

E. P. Lyon

University of Minnesota

A NEW METEORITE

About 6:20 p.m., July 4, 1917, there fell within the corporate limits of Colby, Wis., in the western part of the city, which is in the county of Clark, an achondritic aerolite, the fall of which was witnessed by a considerable number of people.

Unfortunately, knowledge of this fall did not come to me until two weeks later and a visit to the locality was made on July 24, at which time the stones had become considerably broken up and dispersed.

Two pieces fell, the smaller about one half mile NNE. from the other. The larger stone fell in a pasture, striking a granite rock, at least two inches in thickness, lying upon or near the surface, breaking this rock into many fragments and itself breaking into twenty-seven or more pieces. The larger mass, weighing 22¾ pounds, penetrated the stiff Colby clay to a depth of five feet. Some of the smaller pieces are said to have distributed themselves laterally in the soil to the extent of about four feet.

The smaller stone fell in a cultivated field without breaking and is said to have penetrated the soil about two feet. This stone is variously described as about 10 x 14 x 3 or 4 inches, 17 or 18 inches by 9 x 9 inches and 21 x 11 x 11 inches at larger end, sloping in two directions to a wedge shape with rounded corners. This piece was said to be entirely covered with crust and to have weighed from 75 to 85 pounds.

The man who extracted it from the earth informs me that it was so cold that frost immediately formed on its surface when exposed to the air.

The Public Museum of the City of Milwaukee has obtained the bulk of the larger mass which will be analyzed and duly published. It probably will be distributed in exchange with several museums.

The stone is of a light gray groundmass, apparently largely feldspathic, containing very few chondrules and thickly shot with pyrrhotite varying from specks a fraction of a millimeter to more or less globular masses 5 mm. in diameter It exhibits sundry black veins and armored surfaces. Its crust shows considerable variation on different pieces, some of which are deeply pitted and others comparatively smooth.

This is, I believe, the sixth meteorite known from the state of Wisconsin and will be known as the Colby meteorite.

HENRY L. WARD

PUBLIC MUSEUM OF THE
CITY OF MILWAUKEE,
July 31, 1917

FILING PAMPHLETS

THE communications relative to filing reprints, bulletins and other pamphlets have been read with considerable interest by the writer and further suggestions are offered.

Having been in experiment station work for a number of years and being on the mailing lists of a large number of stations, the literature, particularly bulletins and circulars, has been accumulating rapidly. Of these, there may be many which may be of no immediate interest and attempts have been made repeatedly to find some system for filing and indexing them, which will give a maximum of usefulness with a minimum of work in arranging and filing. Many of the various systems have been tried with the result that owing to the time required for arranging, one becomes confronted with an almost hopeless stack of publications if the work be neglected even for a short time.

Numbering in the order of acquisition was early abandoned, on account of the time necessary for preparing index cards and the cross refernces which sooner or later become inevitable, and the resulting jumbled mass of publications on the shelves. Filing according to origin, as by experiment station in the case of such publications, was tried, but this, too, required a card index and, as in the former system, the necessary picking over of the entire shelves when a number of publications on one subject were desired. Filing by author led to the same results. It was finally concluded that in order to obtain a higher degree of efficiency it would be necessary to combine indexing with filing, thus doing away with a large number of indexing cards, and at the same time some of the deficiencies of the other systems of filing. This conclusion led to a search for a fairly complete scheme of classification. The Dewey system was consulted and was found wanting, particularly because the division agriculture was not classified finely enough. The solution of the problem was found in the scheme of classification of the Library of Congress. This may be procured from the Superintendent of Documents at a small price and answers the purpose very well.

In using this scheme, the publications are numbered according to the class number of the subject and placed in the proper filing boxes for each particular subject or subjects. Where a pamphlet contains information on more than one subject it is only necessary to prepare a cross reference card of fairly large size and file it in its proper place among the publications. To prevent "burying" of a publication, a register is used in which the publications are listed according to their origin with their class numbers. With this arrangement it is possible to locate immediately any publication, even if only its origin is known. The chief advantage of the scheme lies in the fact that all material with cross references on any given subject are immediately available.

For agricultural workers in special lines the classification may not be complete enough but this may be easily remedied by preparing an outline for more minute classification. For the purposes of the writer the heading insecticides and fungicides was further subdivided and this has been very satisfactory so far. As the worker in insecticides and fungicides is often called upon for chemical information in other closely related lines such as parasiticides, germicides, weed killers, poisons for vertebrate pests and the like, it has often been debated whether the classification should belong under economic entomology, where it now is, or agricultural chemistry, or whether there should not be a special heading under agriculture for the entire subject or group of subjects. In such a case, the entire branch might be included under the heading "economic toxicology." This name the writer believes to be original and it appears to fill the need for a name for such a diversified and yet closely related group of subjects.

As to the actual storage of pamphlets, any of the suggestions found in the various communications are of value, provided the unit holder be not too large to facilitate the location of any particular publication.

M. R. MILLER

INSECTICIDE AND FUNGICIDE LABORATORY,
UNIVERSITY OF CALIFORNIA

QUOTATIONS

FINANCIAL SUPPORT FOR THE NATIONAL RESEARCH COUNCIL

AT the request of the President of the United States, the National Research Council has been engaged during the past year in mobilizing the research forces of the nation. It has been an enormous task, to which many of the most brilliant workers of the country have given their undivided time. The work has gradually and logically centered at Washington, and the research forces of the country are now quickly available to any department of the government. Development has proceeded to the point where this organization can be truly considered a going machine, forming a connection between the research workers of the country-at-large and the government, and serving as a valuable coordinating influence. With the preliminary work now accomplished, its full value will be more and more nearly attained with each succeeding day.

For the continuance of the work, however, funds will be necessary. Up to the present its operations have cost the government absolutely nothing. office rent, stationery, postage, clerical assistance, etc., have been provided by private contributions, and the time of members of university staffs has been contributed by the respective institutions. For so important a body such an existence is too precarious. If the government needs war material it pays for it and a willing citizenry furnishes the funds through taxation. Are the brains of our scientific men less valuable in this crisis than coal or cotton? As an American citizen we hope that Congress before adjournment will supply adequate funds for the carrying on of the work of the National Research Council on the most intensive and extensive scale possible. We are unwilling to believe that the government of the United States is so pauperized that it must depend on "the passing of the hat" or that it is willing to continue to draw further upon the seriously impaired incomes of our universities in order that the salaries of the men engaged in this work may be met.—*Journal of Industrial and Engineering Chemistry.*

SCIENTIFIC BOOKS

The Principles of Aerography. By ALEXANDER MCADIE. Rand McNally & Co., Chicago. 1917. 318 pp., 8vo, 51 ills., 59 charts and diagrams.

"The Principles of Aerography" deals with the most recent advances in meteorology. As to its title, turning to Murray's Dictionary[1] we find the following: "Aerography, description of the atmosphere. 1753 Chambers Cycl. Supp., 'Aerography, a description of the air, or atmosphere, its limits, dimensions, properties, etc.' 1818 in Todd." This long-forgotten synonym for "meteorology" Professor McAdie seeks to restore as a title for the study of the atmosphere particularly in relation to human safety and progress. The word "meteorology" is so well-intrenched, however, and so comprehensive, that it is not likely, in our generation at least, to be replaced by "aerography."

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[1] "A New English Dictionary," 1888, Vol. 1, p. 146.

The purpose and scope of the book are summarized in the opening sentence of the preface, ". . . to present this new knowledge [of about the last ten years] in a convenient form even if considerably condensed." There is much direct quotation. Thus we have here a useful supplement to American text-books in meteorology, of which the last comprehensive one was published in 1912. The points emphasized are necessarily not the well-known tenets of the science, but its recent developments. "Stress is laid on modern methods of attack and the practical application of whatever knowledge is already available." The most noteworthy feature is the exclusive use of metric and absolute units.

Unfortunately, coherence and clearness seem to have been sacrificed to brevity in the attempt to make the book a college text; with short chapters, numbered sections, and paragraph headings. The successive chapters are: "A brief history of meteorology; units and symbols; temperature scales; thermodynamics of the atmosphere; stratosphere and troposphere; the circulation of the atmosphere; the major circulations; the minor circulations; forecasting storms; the winds; the water vapor of the atmosphere; condensation; dust and microbes; atmospheric electricity; precipitation; floods and notable storms; frosts; [and] solar influences." The lack of a more systematic arrangement of the material probably will be a serious obstacle in the way of the use of the book as a text-book.

The subjects included are, for the most part, well chosen, though many are too briefly discussed. The consistent use of metric units of measurement and weight, and the absolute scale of centigrade temperature and of atmospheric pressure is highly commendable. The author's tables in these units, and his interpretations of aerodynamics place these complexities within reach of the well-taught student. The student, however, may be confused in having absolute pressure units presented as "kilobars" when they are commonly known as "millibars." "Kilobar" has historic precedence over "millibar," it is true; but "millibar" is the internationally accepted term.

On account of omissions or the tantalizing shortness in the treatment of many interesting subjects, the reader may wish that Professor McAdie's book were twice as long. For example, few students probably can understand the brief explanation of energy used in expansion (p. 43); and some may search in vain for an explanation of the prevailing westerly winds. Seeming contradictions are confusing: thus, a statement of the presence of great polar low pressures is followed by a mention of polar high pressures (pp. 54 and 56). It is hard to reconcile the following statement with all other mentions of the temperatures of the upper air: "10° A. Effective temperature of space. At an elevation of 80 kilometers (50 miles) the temperature ranges from 5° to 10° A." (p. 287). This is contrary to the radiation theory of the temperatures of the stratosphere (pp. 50 and 51); and up to 30 kilometers, at least, there is no observational basis for this assumption. Again, some one might ask why the temperature of the atmosphere is below the effective temperature of space. In some places the discussion hinges on quantities depending on perhaps three variables, of which only one is stated: on p. 43, the weight of a cubic centimeter of dry air is stated without mention of temperature and pressure; on p. 58, deflecting force is evaluated without specification of the latitude. Many of the erroneous or weak places in the book are ascribable to brevity. An error may be noted here (p. 139): "[In the atmosphere] if there should be no gradient [of temperature], we should have the density the same throughout, and the temperature at the highest level would be the same as below." Density could not be the same, for the air is compressible. Finally, a student may wonder at the apparent accuracy with which downpours of rain are measured in all kinds of places, when he sees, for instance, that in a rainstorm lasting "0.0083" hours it rained at a rate of 480 mm. per hour (p. 216).

The volume will probably be of greatest value as a reference accompaniment to a well-ordered course in meteorology. As a reference book for the advanced student, however, it is lacking in footnotes or bibliography; but it offsets this with its wealth of tables computed only with difficulty, and of illustrations and diagrams drawn from valuable, inaccessible sources.

Charles F. Brooks

Washington, D. C.

Cancer, Its Cause and Treatment II. Volume. By L. Duncan Bulkley. New York, Paul B. Hoeber. 1917.

The author believes, as he explained in his preceding book and as he further elaborates in the second volume, that cancer is essentially excessive intake of animal proteid which is a constitutional disease, due to a faulty nitrogen metabolism. He maintains that it is an excessive intake of animal proteid which is responsible for the great prevalence of cancer. There are additional factors in the etiology of cancer, but they are of relatively minor importance. In the second volume the author records in greater detail his investigations into urinary and blood changes in cancer and some results of his treatment which consists essentially in a vegetarian diet aided by a certain cathartic. In addition the author accepts the views of Ross, according to which cancer is due to a lack of balance in particular mineral salts of the body, especially in the salts of potassium. Dr. Bulkley finds the conclusions of Ross confirmed in his own practise, in which he noticed that a prescription containing potassium acetate gave eminently satisfactory results in the treatment of cancer.

Leo Loeb

Washington University Medical School

THE VANISHING INDIAN

The progress of miscegenation among many of the Indian tribes has progressed to a degree that is surprising even to those who for many years have been studying the Indian. While the total number of "Indians" as recorded by the census increases from decade to decade, the fact is that this increase is due wholly to that of mixed bloods; the full-bloods of pure strain are in most localities rapidly disappearing and in a considerable proportion of the tribes have become actually extinct or are on the point of extinction.

Two remarkable examples of this fact have just been experienced by the writer. For years a growing necessity in American Anthropology has been to determine the physical type of the Shawnee, once a large tribe and one of considerable historic importance. No great difficulty was apprehended in this task, as the tribe is still well represented. The most promising part of the tribe was that of the so-called "absentee" Shawnee, on the Shawnee Agency in eastern Oklahoma. They count 569 individuals, quite a few of whom are generally regarded as "full-bloods."

Due to a grant of $100 from the Committee of One Hundred on Research of the American Association for the Advancement of Science, the writer was able to visit the tribe during the early part of August of this year. To his great disappointment the task of finding some pure-bloods became exceedingly difficult. Quite a few of the Indians were found to be "full-bloods," but on inquiry into the family history it was generally learned that the subject was a mixture of Shawnee with the Oneida, Delaware, Creeks, or some other tribe. In conclusion, there were found but three individuals who so far as they or their friends knew were full-blood Shawnee. Two of these were old women and one an old man, all near or over 70 years of age, and two of the three were sister and brother.

The next tribe visited were the Kickapoo, the main body of which to the number of 211 is settled about McLoud, Oklahoma. They were said by the old Shawnee to be practically the same people with themselves, having at some time in the past had but one camp-fire, and it was generally believed that they would show some full-bloods of pure strain. This proved to be a vain hope. On close inquiry all sorts of mixtures were discovered, even among the oldest men and women of the tribe, but no pure-bloods. Only one single woman of middle age was believed to be possibly a full Kickapoo, but there was no real certainty. Some visiting Kickapoo from Mexico proved no better than the rest, and no hope was given that any pure strain Kickapoo could be found anywhere else.

Thus two tribes, one of which was of considerable importance, may be regarded as lost to science, so far as pure-bloods are concerned. Only a few years ago according to local information there were still a number of old men and women living in both tribes who represented the pure strain. The genuine Indian is rapidly passing away and the work of the anthropologist who endeavors to record the physical type of the various tribes is becoming increasingly difficult.

ALEŠ HRDLIČKA

UNITED STATES NATIONAL MUSEUM

ON A SUDDEN OUTBREAK OF COTTON RUST IN TEXAS

IN June 10, 1917, the attention of the writer was called to an outbreak of cotton rust. The specimens were first collected at Mercedes and Edinberg, Texas. A review of the literature seemingly showed that in the United States, the cotton was supposed to be free from rust. The Experiment Station Literature however refers to cotton rust which is not a true rust, but various leaf spots caused by *Pseudomonas malvacearum* E. S. and *Glomerella gossypii* (South.) Edg.

Symptoms.—The disease is characterized by circular spots which vary from one tenth to one quarter of an inch in diameter. The spots, however, are often much larger in size when they appear singly and become considerably smaller when many of them occur on the same leaf. The æcia are found to be thickly studded on the spots of the upper part of the leaf. The æcia are typical of all rusts of this type, and when mature the spores are liberated by the least wind or touch, forming a yellow powder on the leaf. The spores readily germinate in water, showing that the rust is a heterœcious species. This same observation was also substantiated by Dr. J. C. Arthur, under correspondence dated July 2, 1917. The disease seems to attack the lower leaves first and especially plants which are well developed and on which cotton bolls have attained considerable size. The area of the present infection was found to begin at about four miles west of San Fordyce on the Rio Grande, running east about thirty-five miles and extending north and south about fifteen miles. In the Mission Sharyland district the approximate acres devoted to cotton are about 500, while further East several thousands of acres have been put to cotton this season. There were few patches in that area which were not affected with rust. About two or three miles north of Mission the first outbreak was reported from the ranch of Mr. Charles Brodgen. Soon other ranchmen reported similar outbreaks of cotton rust. The first infection was noticed immediately after a long rainy spell which lasted about three weeks. The rain consisted of short showers, which kept the air very humid. The disease was more serious on older patches and where irrigation was resorted to. Where irrigation and cultivation was slightly neglected infection was found to be very mild. In the same field in those plants which were most protected from either wind or by a top growth infection was heaviest on the lower leaves. Cotton which was planted very close and those plants in the field which made the heaviest growth were also found to be most affected. While infection is confined to the lower leaves, the disease may also be found on the bracts of the bolls. Careful observation so far has not disclosed it on the stem of the cotton plant.

It does not seem probable that this rust has prevailed to any serious extent in the Cotton States before. Some of the oldest cotton growers of Hidalgo County of Texas claim that from their experience of nearly fifty years with cotton, they have never seen this rust. Many Mexican cotton growers on the Texas border too make similar statements, while one or two others insist that they have seen it before. It seems therefore a puzzle how this rust has escaped the general attention of cotton growers. There is this point which might be of value in considering the source of the present outbreak. The Rio Grande valley receives its irrigation water, not from the Rio Grande, as is commonly supposed, but from the San Juan river and other Mexican rivers. The waters from these rivers empty in a basin or valley in which cotton grows. It is therefore very probable that the waters of the San Juan river have introduced weeds which act as a host to the possible *Puccinia* stage of this rust. It is also probable that the waters of these rivers have carried sporidia from Mexican sources, which were now responsible for the infection of the cotton; all this however is problematical.

Cause.—The disease here reported is a true rust. The æcial stage occurs on the cotton while the *Puccinia* stage undoubtedly occurs on some other host, unknown as yet. In submitting specimens of this cotton rust to Dr. J. C. Arthur, he pronounced it *Æcidium gossypii* E. & E. suggesting also that this rust might come from some grass form, probably *Muhlenbergia*, or *Sporobolus;* Dr. Arthur has specimens of this rust in his herbarium, which was collected by Heald and Wolf at Falfurrias, Texas, September 2, 1909, and two Mexican collections, one from San Jose del Cabos, September 2, 1893, the other from Tlahualilo, collected about 1907, probably by Herrera. Dr. W. A. Orthon[1] states that he has specimens of this rust in his herbarium which were collected in Florida found one year in an experimental plat at Miami. His other specimens came from Falfurrias and other points of the Rio Grande valley, collected seven years ago. From this it is evident that the cotton rust must have been present in Texas and elsewhere, though it did not attract the attention of cotton growers or pathologists. *Æcidium gossypii* E. & E. was first described in *Erythea,* 5:6, 1897. Unfortunately the writer was unable to secure a copy of this publication. There seems no doubt however that the present cotton rust is the same as that which was originally described as *Ascidium gossypii* E. & E. *Uredo gossypii* Lagh. is another but inconspicuous rust which attacks cotton. This is prevalent in Cuba, Porto Rico and southern Florida, twenty-seven collections of which are found in Dr. Arthur's herbarium. It is very likely that the same rust may be found to be more widespread in the cotton states, although it may be easily overlooked because of its inconspicuous nature. *Uredo gossypii* resembles very much any other ordinary *Uredo.*

A careful search of *Æcidium gossypii* in the affected district in Texas has as yet failed to reveal the presence in cotton fields of any grasses belonging to the genus *Muhlenbergia* or *Sporobolus.* On the other hand there are numerous grasses in that locality which are found to be affected by various rusts. More recent investigations have disclosed the fact that there are no new infections found on the cotton since the last outbreak was observed. Moreover the æcidial stage on the previously affected cotton leaves is now found to have dried, leaving no traces of viable spores. The original spots as well as the old cluster cups are overrun by a varied mycological flora. Just what became of the æcidial stage is hard to explain. It is not likely that new infections will start again on the cotton this year. The problem on hand therefore is to determine if possible the alternate host which hibernates the *Puccinia* stage. Drs. Olive and Arthur, as well as the writer, are now working on this phase, and it is hoped that the *Puccinia* stage will be found so that the host which hibernates it will be destroyed, thereby preventing the further spread of cotton rust.

In conclusion the writer wishes to express his indebtedness to Dr. J. C. Arthur for helpful suggestions and for identifications of specimens. Grateful acknowledgments are also due Dr. J. J. Marton, agricultural agent of the Texas State Department of Agriculture, for the hearty cooperation and for information on the spread of cotton rust in the Rio Grande valley of Texas. J. J. TAUBENHAUS

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[1] Correspondence dated July 25, 1917.

DIVISION OF PLANT PATHOLOGY
AND PHYSIOLOGY,
TEXAS AGRICULTURAL EXP. STATION,
COLLEGE STATION, TEXAS

SPECIAL ARTICLES

THE EFFECTS OF ACIDS AND SALTS ON "BIO-COLLOIDS"

MIXTURES of agar with gelatine, albumen, protein, urea or amino-acids in which the agar forms seventy-five per cent. or more of the whole, show a similarity of imbibitional behavior to that of sections of plants and hence for convenience in the present studies may be termed *"bio-colloids."* The results of a series of tests with a wide variety of nitrogenous substances from urea to albumen were in general agreement to the effect that such substances mixed in proportions of one to ten, more or less, with agar, when made into thin dried plates, swelled enormously; 2,000 to 3,000 per cent. in distilled water, one half to one tenth this amount in hundredth-molar hydrochloric acid, and more or less in hundredth-molar sodium hydrate[1]

An extension of the tests of the effects of nitrogenous substances upon the swelling of the amorphous carbohydrates was made to include a mixture of agar and peptone the swelling measurements of which were as follows:

AGAR 90—PEPTONE 10

Water	HCl *M*/100	NaOH *M*/100
3166.6%	500% (20 hours)	633%
———	566.6 (20 hours)	800
———	633.3 (48 hours)	1,666.6

The chief feature of interest in these results is the uniform swelling in alkali in excess of that in hydrochloric acid, in a manner slightly different to that of similar mixtures in which other nitrogenous substances were used.

The chief purpose of the entire series of studies has been to ascertain what conditions of growth and development might be identical with the factors affecting imbibition. The fact that plant protoplasts usually consist of a large proportion of carbohydrate gels with a smaller proportion of nitrogenous material has already been discussed. The resulting colloidal mixture may be acidified as a result of certain respiratory processes, or this acid may be broken up as fast as formed, in which case the protoplast might be in a deacidified or neutral condition and from this might vary to alkaline under conditions which we are not yet ready to describe. Acidification and deacidification of the cell may take place at a rapid rate and be complete within a short time, according to the bulk of the cell-mass, temperature and other conditions.

Hydrochloric acid had been used in nearly all of the earlier work for acidification of colloids, since most of the known facts as to the swelling of gels are referable to it. The acids of the plant are organic, and a modification of the technique to heighten the similarity between the experiments and the action of the plant was to substitute citric for hydrochloric acid in the series.

Preliminary to this substitution, series of swellings were carried out to test the relative action of the two acids, with the following results from dried plates of mixtures of 90 parts agar and 10 parts bean protein:

Hydrochloric Acid *M*/100	Citric Acid *M*/100	Sodium Hydrate *M*/100
541 6%	916.6%	916.6%
	875	
	875	
300	402	400

The effect of this organic acid in this initial series of tests was to produce an imbibitional swelling fairly equivalent to that of sodium hydrate and to cause such colloidal mixtures to take up more water than in hydrochloric acid. An extended series of measurements will be necessary before any serious conclusion can be formulated, however.

Another set of factors arising from the presence and concentration of salts is next to be considered. Certain of these compounds are invariably present, although in varying concentration, and any attempt to apply studies of imbibition to swelling and growth problems must take into consideration the fact that the various reactions due to the presence or proportion of nitrogenous compounds, alkalinity or acidity, invariably ensue in saline solutions, attenuated as they may be in young protoplasts. Tests were therefore planned to determine the action of the common bases and acids on bio-colloids.

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[1] See "Growth and Imbibition" presented before the American Philosophical Society, April, 1917, and now in press in the *Transactions* of the society; also "The Behavior of Certain Gels Useful in the Interpretation of the Action of Plants," SCIENCE, 43, p. 484, 1917.

Agar which has been used to represent the carbohydrate constituent of living matter gave the following results when dried plates .28 mm. in thickness were tested:

Water	Potassium Nitrate		
	M/100	*M*/50	*M*/10
2,325%...	1,535.7%	910 7%	607 1%
	Calcium Nitrate		
	785.7	—	500

The amount of swelling as compared with distilled water was decreased by both salts and the inhibiting action increased with the concentration.

A mixture of 90 parts agar and 10 parts of glycocoll gave the following swellings:

Water	Potassium Nitrate		
	M/100	*M*/50	*M*/10
3,266.6%. ..	1,800%	1,733.3%	1,333.3%
	Potassium Chloride		
	1,733.3	1,666.6	900
	Calcium Nitrate		
	1,333.3	1,200	800

From which may be seen that an inhibiting effect on imbibition in the bio-colloid similar to that of agar was exerted by these salts, the effect increasing with the concentration and the least swelling taking place in the calcium compounds.

A mixture of 90 parts agar and 10 parts of peptone gave the following swelling measurement.

Water	Potassium Chloride *M*/100	Potassium Chloride, Hydrochloric Acid *M*/100
2076%	1230.8%	500%

Water	Potassium Nitrate		
	M/100	*M*/50	*M*/10
3,166.6%.....	1,600%	1,300%	866.6%
	Calcium Nitrate		
	1,133.3	1,133 3	733.3
	Potassium Chloride		
	1,266 6	—	1,000.0

The lessening or inhibitory effect is seen to increase with the concentration, and less swelling takes place in equivalent calcium solutions than in potassium. The irregularities, however, suggest that peptone mixtures present some special characters which will need further analysis.

Dried plates of a mixture of 90 parts agar and 10 parts urea gave the following swelling measurements:

Water	Potassium Nitrate		
	M/100	*M*/50	*M*/10
2933 3%.. ...	1533 3%	1233 3%	766.6%
2933 3	1133.3	813 3	700
	Calcium Nitrate		
	813.3	813.3	500

These results are in general accord with those obtained from other nitrogenous mixtures.

A mixture consisting of 10 parts of gelatine and one part of mucilage from *Opuntia* might be considered as equivalent to the colloids consisting of 90 parts gelatine and 10 parts agar, and gave the following swelling measurements.

Water	Potassium Nitrate		
	M/100	*M*/50	*M*/10
589.4%... ...	485 5%	455 3%	698 2%
	Potassium Chloride		
	473.2	473.2	401.9
	Calcium Chloride.		
	473.2	....	348.2

The swelling increases within the range of concentration of potassium nitrate used, and appears to decrease slightly within similar concentrations of potassium chloride, and is checked to a greater extent by calcium chloride, although the last named solution would have a slightly alkaline reaction due to the hydrolysis of the salt.

The effect of salts alone on the bio-colloid in which gelatine forms the nitrogenous constituent is shown by the following measurements of the swelling of a series of dried plates of 90 parts agar and 10 of gelatine, .22 mm. in thickness:

Water	Potassium Nitrate		
	M/100	*M*/50	*M*/10
1,136.4%.....	940.9%	772.7%	613.7%
	Calcium Nitrate		
1,454.5%.. ...	840.9	704.5	409.1
	Potassium Chloride		
	M/100	*M*/50	*M*/10
	1,000	772.8	590.9
	Calcium Chloride		
	704.5	545.4	386.4
	Sodium Chloride		
	939 (average of 3 tests)		

The next step to be taken was one in which the effect of the universally present salts were tested in various concentrations in connection with conditions of acidity and of deacidity.

As an example of such tests the results obtained by a study of the action of dried plates of a mixture of 90 parts agar and 10 parts bean protein are given below:

Calcium Chloride *M*/100	Calcium Chloride Hydrochloric Acid *M*/100
769.2	538.5

It is apparent from these results that acidity decreases the amount of imbibition in the presence of the salts tested.

A few tests made to determine the limits of imbibition in concentrated solutions revealed the fact that dried plates of 90 parts agar and 10 parts of bean protein swelled 576.9 per cent. in a saturated solution of potassium nitrate which has an osmotic coefficient of about 60 atmospheres. The same material swelled 730.9 per cent. in a solution of 50 g. of calcium nitrate in 100 cc. of water (2-molar solution) which has an osmotic coefficient of about 44 atmospheres. A swelling of 100 per cent. was shown in a 3-molar solution of calcium chloride and if hundredth molar hydrochloric acid was added the swelling was increased to as much as 200 per cent. These facts illustrate very forcibly the possibilities of imbibitional absorption against osmotic action. The significance of such action in parasitism and nutritive couples has been discussed elsewhere.[2]

All tests in which the samples of colloid are presented to the action of the reagent in a neutral and dried condition are of course widely different in hydratation conditions from those prevalent in the protoplast. The colloids of the living material are continuously subject to interaction and to modifications resulting from the action of salts, acids, alkalies and their combinations.

A few tests in which plates of bio-colloid swelling from the action of one solution are subjected to another have already been described. The possibilities presented, however, are such as to justify the minutest examination.

In one series dried plates of 90 parts agar and 10 parts bean protein were first subjected to the action of alkali, to hydrochloric acid and to citric acid separately for eighteen hours, at the end of which time their full imbibitional capacity had been reached under the separate influence of each of these reagents. The solutions were then pipetted off and a second reagent introduced. The initial and the secondary action are indicated below.

First Swelling

Hydrochloric Acid *M*/100	Citric Acid *M*/100	Sodium Hydrate *M*/100
300%	402%	400%

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[2] See MacDougal, D. T., "The Beginning and Physical Basis of Parasitism," *Plant World*, 1917 in press.

A number of tests were made in which the same bio-colloid was successively subjected to a series of reagents with exposures of two hours or more to each one in succession as follows:

Sodium Hydrate M/100	Sodium Hydrate M/100	Hydrochloric Acid M/100
360	300	Slight and irregular shrinkage.

Plates of agar 90 parts gelatine 10 parts, .07 mm. in thickness swelled 1,148 per cent. in 45 minutes in distilled water, then 218 per cent. in $\frac{\text{HCl}}{\text{KCl}}\,\frac{M}{100}$ in 2 hours, then 430 per cent. in KCl(M/100) in the next 4 hours, after which it stood in the acidified potassium chloride solution without measurable change for 11 hours. The replacement of this solution by a hundredth molar sodium-hydrate solution was followed by an increased imbibition equivalent to 643 per cent. of the original plate in two hours, at the end of which period it had swelled altogether about 2,400 per cent. of its original thickness.

A similar plate swelled initially 3,357 per cent. in 14 hours in water, then shrank about 300 per cent. in a hundredth molar acidified potassium chloride solution in 11 hours, after which it swelled about the same amount in hundredth molar hydrate.

Some very striking results were obtained by plates .12 mm. thick of 90 parts agar and 10 parts bean protein. A trio of samples swelled 1,416.5 per cent. in 4 hours in distilled water, then shrank 208 per cent. in hundredth molar acidified potassium chloride in 3.5 hours, then swelled 643 per cent. in hundred molar sodium hydrate in 13 hours and 1,250 per cent. in distilled water in 14 hours. At the end of this time a total increase of about a hundred per cent. in hundredth molar hydrochloric acid took place. A second trio of same material swelled about 400 per cent. in less than an hour in water, then 200 per cent. in 3 hours in hundredth molar acidified potassium chloride solution, then 750 per cent. in 3.5 hours in hundredth molar sodium hydrate, 1,583 per cent. in water in 10 hours. After this total imbibition of about 2,500 per cent. had been reached immersion in hundredth molar acidified potassium chloride for 3 hours produced a dehydration of only 167 per cent., not all of which was regained when the acidified salt solution was replaced with water.

These two series serve to illustrate changes in imbibition capacity which might take place in the protoplast. It would be highly unwise to generalize upon the basis of the meager results available, yet the records described suggest certain reasonable assumptions. Among those may be included the inference that after a plate of bio-colloid is in a swelling stage the addition of an acidified salt solution checks the rate of swelling if the total amount is still below that possible in the solution. If the swelling is already beyond the total possible in the acidified salt solution some dehydration occurs, but by no means enough to reduce the swelling to the acidified salt total. Dehydration effects from hydrochloric or citric acid were very slight. The application of alkalies in advanced stages of swelling after acidified salt solutions seemed to increase swelling beyond the total possible in a simple immersion in alkali.

Analyses of modifications of growth rates must therefore take into account not the simple total effect of any solution upon the colloids of the enlarging protoplast, but upon these bodies as already modified by previously acting solutions.

The chief interest in all of the experimentation on imbibition described in this and in previous papers has been directed to various effects simulating growth by acids, alkalies, salts and combinations upon bio-colloids as illustrated by the mixtures described. The differential action which might ensue from the addition or subtraction of a nitrogenous compound from the carbohydrate body of protoplasts in special tracts, changing the imbibition capacity of chromosomes, of spindles or cell plates, etc., may well play an important part in the mechanics of mitosis and cell division.

D. T. MacDougal,
H. A. Spoehr,

Desert Laboratory,
Tucson, Arizona,
June 4, 1917

SCIENCE

FRIDAY, SEPTEMBER 21, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J McKeen Cattell, Garrison-on-Hudson, N Y

THE MAGNETIC FIELD OF AN ATOM[1]

THE substance and structure of the atom, the movements of its parts, and its properties, are, perhaps, the most fundamental subjects of modern physical investigation. And although the structure and even the substance of the atom can as yet only be inferred, nevertheless its numerous and varied phenomena not only challenge the theorist, but also, through their manifold checks, afford him at every turn the very best guidance to an approximately correct inference. Among the more important of these phenomena are the actions of atoms in respect to absorption and emission of radiation under various conditions of temperature, pressure, magnetic and electric fields. Crystal forms, chemical reactions and magnetic properties offer additional suggestions and valuable tests.

One of the most interesting inferences concerning the atom is this: that it has a very powerful magnetic field. This inference is supported by a number of investigations of entirely different character which it is proposed in what follows to outline briefly and in approximately their chronological order.

1. The electromagnetic theory of ether vibrations so satisfactorily accounted for many known phenomena and so successfully predicted others, including wireless telegraphy, that it was long ago generally believed that all radiation, including light,

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[1] Presented at the symposium on "The Structure of Matter" at a joint meeting of the Sections of Physics and Chemistry of the American Association for the Advancement of Science, The American Physical Society and the American Chemical Society, New York, December 27, 1916.

must have its origin in rapidly oscillating or orbitally moving electric charges whose periods are the same as the periods of the emitted radiation. Further, since spectral lines, except those belonging to bands, were found always to be characteristic of the elements and never of their compounds, it soon became evident that the corresponding radiations are of atomic and not molecular origin. Hence the natural conclusion that the *atoms* of all elements, *for* all give line spectra, are either associated with or consist, in part at least, of electric charges undergoing complete periodic changes of distribution or position at the rate obviously found by dividing the velocity of any given radiation by the corresponding wave-length, changes, therefore, in the case of green light, at the rate of some six thousand million million per second. Such numbers, of course, are appalling, but the logic is inexorable.

2. In 1885 Balmer[1] announced his remarkable though empirical series formula as applied to the visible hydrogen lines H_α, H_β, H_γ and H_δ; that is

$$\frac{1}{\lambda} = N\left(\frac{1}{2^2} - \frac{1}{n^2}\right), \quad n = 3, 4, 5, \text{etc},$$

a formula that has since been found to give with great accuracy the wave frequencies of the whole hydrogen series of at least 35 lines. The same general formula, or some modification of it, such as Rydberg's,

$$\frac{1}{\lambda} = N\left(\frac{1}{a^2} - \frac{1}{(n+c)^2}\right),$$

gives with equal accuracy the wave frequencies of the lines of many other series of various elements.

Here, then, was a further important hint in regard to the structure of the atom, but for a long while no one interpreted what it meant.

3. In 1897 Lord Rayleigh[2] emphasized the fact that the vibrations producing spectral series hardly could result from ordinary elastic or electric forces of restitution since each of these gives equations involving squares of the frequencies—the displacement being expressed in terms of sin t/λ its acceleration involves the factor $1/\lambda^2$—while the Balmer and similar formulæ that so closely follow the lines as they actually occur contain *only first powers* of this term.

Although Lord Rayleigh's paper was essentially negative in respect to atomic structure, it nevertheless was an important contribution to this difficult subject in that it rendered well nigh untenable certain theories that appeared then to be more or less generally held, namely, all that compared the atom to an elastic sphere, parallelopiped, or other solid, and those alike that assumed it to be some unknown type of Hertzian oscillator.

4. In the meantime two other important spectroscopic phenomena were announced that at first seemed to render far more difficult any satisfactory interpretation of the atom and its structure. These were, *a*, the pressure displacement of spectrum lines, discovered by Mohler and the author[3] in 1895, and, *b*, the magnetic resolution and dispersion of such lines, discovered by Zeeman[4] in 1896.

5. About this same time investigations on electric discharges through gases, and analogous phenomena, became world wide, initiated mainly by the wonders of the X-rays and largely sustained by the frequent stimuli of new discoveries by Thomson, Rutherford, Madame Curie, and their brilliant associates.

Among the many important results of

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[1] *Ann. der Phys.*, 25, 80, 1885.

[2] *Phil. Mag.*, 44, 356, 1897.

[3] *Astrophys. Jr.*, 3, 114, 1896.

[4] *Phil. Mag.*, 43, 226, 1897.

these numerous investigations are the discoveries that negative electricity occurs in multiples of a perfectly definite and accurately measurable unit; that this unit, the negative electron, perhaps in large numbers, is at least an integral part of all atoms; that electrons often are ejected from an atom; that when ejected they leave with enormous velocities; that when in motion they possess inertia; and that this inertia increases with the velocity.

Naturally such discoveries suggested the Saturnian and other similar atomic models, several of which have been elaborately discussed.

6. In 1906 the author[5] computed the possible magnetic field of a Saturnian atom and found in this field a vera causa, perhaps an adequate cause, of the hitherto unexplained pressure shift of spectral lines. A simple presentation of the argument is as follows:

Assuming Thomson's Saturnian atom of revolving rings of electrons, it seems probable that the wave frequency of the radiation emitted by any one of the rings of a given atom may be a simple multiple of its orbital frequency. Any bunching, for instance, of the electrons, however temporary, would produce radiation whose frequency was the same as that of the complete orbital revolutions. But this revolution of rings of electrons, presumably around a common axis, constitutes so many circular electric currents which obviously produce solenoidal magnetic fields, and themselves are subject to inductive effects.

Now it has been shown by Langevin[6] that in the case of a ring of electrons any forced change in the magnetic flux merely alters the orbital speed without changing the radius. Hence the self induction remains constant and if E be the induced electromotive force, then

$$E = L\frac{di}{dt} + Ri,$$

in which L is the self-induction, R the ohmic resistance and i the strength of the current. But in the case of an atomic ring of electrons $E = dN/dt =$ rate of change of magnetic flux through the ring, and $R = O$, presumably.
Hence

$$\frac{dN}{dt} = L\frac{di}{dt},$$

and

$$di = \frac{dN}{L}.$$

That is, the induced current in the ring is directly proportional to the change in the magnetic flux through it. Furthermore, the induced current is permanent instead of momentary as in ordinary circuits, so long as the change in N is permanent.

In this connection it is interesting to note that Kamerlingh Onnes[7] has recently shown by a series of brilliant experiments that an induced current may last for hours with but little reduction (less than 1 per cent. per hour) in a lead wire solenoid at very low temperatures.

Now, from the Zeeman effect it is obvious that radiating atoms are acted upon by an external magnetic field, and, therefore the inference is immediate that these atoms themselves possess magnetic fields of their own—*they could not otherwise be acted upon by a magnetic force.* Also, since the the kind and magnitude of the Zeeman effect is independent of temperature, as shown by both radiation and absorption, it follows that the atomic field must also be independent of temperature.

Further, as magnetic fields are known always to exist in connection with electric currents, and not certainly known ever to be due to any other cause, and as moving electrons constitute the only known electric current, it therefore will be assumed that the atom's magnetic field is due to orbitally revolving rings of electrons, subject to temporary bunchings or other disturbances, possibly the shift of an electron from one ring to another, that render the ring so disturbed, or the shifting electron, radiative during the brief interval in which equilibrium is being regained.

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[5] *Astrophys. Jr.*, 23, 233, 1906.

[6] *Journal de Physique*, 4, 678, 1905.

[7] *Nature*, 93, 481, 1914.

Let v be the velocity of light, λ the wavelength of the emitted radiation, ω the angular velocity of the electrons as seen from the center of the orbit, S the average strength of the enclosed magnetic field, K a constant and n a whole number, perhaps unity. Then

$$\frac{v}{\lambda} = \frac{n\omega}{2\pi} = KS \tag{1}$$

Hence

$$\mp \frac{v\,d\lambda}{\lambda^2} = \pm K\,dS \tag{2}$$

From (1) and (2)

$$\mp \frac{d\lambda}{\lambda} = \pm \frac{dS}{S}.$$

But dS is added to the fields of some atoms and subtracted from the fields of others by the application of an external magnetic field of strength H to any mass of gas. Hence

$$\mp \frac{d\lambda}{\lambda} = \frac{H}{S}.$$

By substituting H for dS in (2) we get

$$\frac{d\lambda}{H\lambda^2} = \frac{K}{v}, \text{ a constant.}$$

But this is the well-known Zeeman law, and therefore it appears that the assumed simple structure of the atom must at least crudely resemble its actual structure.

From the known values of H, λ and $d\lambda$ the computed value of S, the average strength of the atomic magnetic field, is of the order of 10^8 gauss.

Similarly from the probable size of the atom, radius $= 10^{-8}$ cm., and the charge of the electron it is easy to calculate the magnetic field at the center of the ring system on any definite assumption of the speed of rotation and number of electrons.

If it is assumed that the period of rotation is the same as that of the emitted radiation, and that N, the number of electrons in the atom, is of the order

$$N = A\,10^8$$

in which A is the atomic weight, a number many investigators regard as probable, then the computed intensity of the magnetic field at the center of an iron, titanium, or other such atom is of the order of 10^8, roughly 2,000 times the most intense field yet produced between the poles of electromagnets.

Whatever the strengths of these fields, each atom must act inductively on all its neighbors and in turn be acted upon by them, to an extent that for each couple varies approximately as the cube of the distance between their centers. If two atoms in the turmoil of the electric arc, for instance, chance closely to approach with similar poles facing each other their mutual induction will be such as to increase the speed of their electrons, and thus for the instant slightly to shift their spectrum lines to the violet. If, however, they approach with opposite poles facing each other the shift will be to the red. But in the second case the atoms clearly will come closer together, thus producing stronger inductions and greater shifts, than in the first. Hence the net result is a displacement of the maximum intensity of the line to the red.

When the gas pressure about the light source, an electric arc, suppose, is low the distance between neighboring atoms is relatively large and therefore during only a correspondingly small fraction of the time is any given atom under the strong inductive influence of others. During the rest of the time the frequency of its vibration is undisturbed. Hence the spectrum lines given out by rarefied gases, in which an atom is only "occasionally" close to another, are comparatively clean and sharp. With increase of pressure the free path is decreased and the total interval of disturbance lengthened to practically the same fractional extent. If, for instance, the pressure is doubled, temperature remaining constant, the free path is halved, atomic "collisions," total duration of an atom's close proximity to others, and, therefore, quantity of shifted light all are at least doubled. Hence with increase of pressure a spectral line must spread (independent of the Doppler effect) and its maximum intensity shift to the red.

Under very heavy pressures the atoms are always within mutually disturbing distances, and therefore under such conditions their lines gradually merge into a continuous spectrum.

It might seem that atoms with such strong magnetic fields necessarily would cluster into rods and rings, like iron filings in a magnetic field. In short, that at any attainable temperature, a gas consisting of such atoms would collapse into—who knows what?

To test this point consider an extreme case. Let two atoms, each consisting of a single circular ring of 5×10^4 electrons and an equivalent positive nucleus at its center, face each other on a common axis, and let the orbital revolution of their rings have the frequency of yellow light of wavelength $.6\mu$: Find the electric and magnetic forces between them.

The magnetic flux through either ring due to the presence of the other is given by the expression

$$N = \frac{2\pi^2 i r^4}{(r^2 + x^2)^{3/2}},$$

in which i is the strength of the current, r the radius of the ring, and x the distance between the centers. Hence the magnetic force between the rings is found by the equation

$$F_{\text{magnetic}} = 2\pi^2 i^2 r^4 \frac{d}{dx} \frac{1}{(r^2 + x^2)^{3/2}} = \frac{6\pi^2 i^2 r^4 x}{(r^2 + x^2)^{5/2}}.$$

Assume the electronic charge to be 4.774×10^{-10}, Millikan's value, and let $r = 10^{-8}$ cm. Then when

$$x = r,$$
$$F_{\text{magnetic}} = 1.6561 \text{ dynes},$$
$$10r \qquad\qquad 100r$$
$$91\ 39 \times 10^{-5} \text{ dyne}, \quad 9\ 37 \times 10^{-8} \text{ dyne}.$$

The electric force between the two atom models consists of four parts; namely, attraction between each nucleus and its neighbor's ring, repulsion between the nuclei and repulsion beween the rings. The problem of computing this force is not so simple as, at first sight, it is likely to appear. However, a general solution of the problem of the rings (rings of different radii and linear densities) in the form of a converging series has been kindly furnished by Professor R. S. Woodward. A similar solution of the somewhat simpler problem presented by duplicate atom models gives the following total electric forces (repulsions) between them:

$$x = r,$$
$$F_{\text{electric}} = 3578 \times 10^3 \text{ dynes},$$
$$10r \qquad\qquad 100r$$
$$34\ 186 \text{ dynes}, \quad 6\ 45 \times 10^{-8} \text{ dyne}.$$

Of course it is not assumed that any such force as that computed for $x = r$, about 3.65 kilograms, actually exists between any two atoms. Neither does it seem probable that atoms can get so close that their centers are separated by only a single atomic radius. However, the calculations appear to prove that the electric forces between any atomic models of the kind here assumed would be more than sufficient to prevent collapse through the interaction of their powerful magnetic fields.

7. In 1907 and again in 1908 Weiss[8] reached the conclusion, through a series of magnetic determinations at various temperatures, that the atomic magnetic field of ferro-magnetic substances is of the order 10^7 gauss.

8. At about the same time, that is, in 1908, Ritz[9] gave an elaborate discussion of a molecular model designed to account for the occurrence of series among spectral lines. He recognized the force of Lord Rayleigh's objection to the assumption of a model in which the electrons vibrated under either mechanical (elastic) or electrical forces, since such forces give equations involving squares of the frequencies. He therefore assumed the electrons to vibrate or describe orbits in planes at right angles to the lines of magnetic fields, under which conditions the reciprocal of the wave-length, $1/\lambda$, is given by the equation

$$\frac{1}{\lambda} = \frac{eH}{mv}$$

in which e is the electronic charge, m the electronic mass, H the magnetic field, and v the velocity of light. Hence for this equation to apply to the spectral region of the average Balmer series H must be of the order of 10^8 gauss.

At the distance r from the adjacent pole of a magnet whose pole strength is μ, and length l,

$$H = \mu\left\{\frac{1}{r^2} - \frac{1}{(r+l)^2}\right\}$$

and

$$\frac{1}{\lambda} = \frac{\mu e}{mv}\left\{\frac{1}{r^2} - \frac{1}{(r+l)^2}\right\}$$

If $l = ns$ and $r = as$

$$\frac{1}{\lambda} = \frac{\mu e}{s^2 mv}\left\{\frac{1}{a^2} - \frac{1}{(a+n)^2}\right\}, \quad n = 1, 2, 3.$$

If $a = 2$

$$\frac{1}{\lambda} = N\left\{\frac{1}{2^2} - \frac{1}{(2+n)^2}\right\}$$

which is identical with Balmer's equation for the hydrogen series.

Hence an electron vibrating at the distance $2s$ from such an elementary magnet of length s and proper strength will give the spectrum line H_α. If 2, 3, etc., of these elementary magnets should be placed end on, the electron would emit H , H_γ, etc., respectively.

Ritz does not state what he considers the probable origin of the elementary magnetic field. As above explained, however, it conceivably may be due to the orbital revolution of the electrons themselves. Further, the different magnetic fields demanded by a Balmer series may, perhaps, be provided by a number of concentric rings of electrons, the field abruptly changing on crossing each ring from one to another interspace. This conception obviates the necessity of assuming the magnets to be placed end on, an arrangement that is impossible if the magnetic fields are of electric origin.

In speaking of Ritz's theory, Zeeman[10] says: "Though there is something artificial about this explanation, it is the best we have at the present moment."

9. Within the past year or two Oxley[11] has shown that the change of magnetic susceptibility on crystallization of some 40 diamagnetic substances examined can be satisfactorily explained on the assumption of molecular magnetic fields of the order of 10^7 gauss. He says in part:

> 1. The change of susceptibility observed on crystallization demands a local molecular field of this order of intensity [10^7 gauss].
>
> 2. The natural double refraction of a crystalline substance as compared with the artificial double refraction which can be induced in a liquid by the strongest magnetic field at our disposal is consistent with the value of the local molecular field implied by (1) for diamagnetic crystalline media.

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[8] *Jour. de Phys.*, 6, p. 661, 1907; 7, p. 249, 1908.

[9] *Ann. der Phys.*, 25, 660, 1908.

[10] "Magneto-optics," p. 182, 1913.

[11] *Phil. Trans. Roy. Soc.*, 215, p. 95, 1915.

3. (1) and (2) together imply that the aggregate of the local intensity of magnetization per unit volume of a diamagnetic substance is comparable with the saturation intensity of magnetization of a ferro-magnetic substance.

4. The above results lead to a correct estimate of the energy (potential) associated with the crystalline structure, in virtue of the molecular grouping, as tested by the magnitude of the latent heat.

5. Lastly, unless the forces binding the diamagnetic molecules together were of the order of magnitude stated, we should not be able to detect a departure of the experimental value of the specific heat near the fusion point from the value calculated on Debye's[12] theory [of specific heat]. Every substance investigated by Nernst and Lindemann discloses such a departure.

The above evidence is sufficient to establish the existence of an intense local molecular field of the order 10^7 gauss, if interpreted magnetically, in those diamagnetic crystalline substances (about 40 of which have been investigated) which show a measurable change of χ [specific magnetic susceptibility] on crystallization.

10. Finally, Professor Ernest Merritt, in an address to the American Physical Society in 1915, showed, through the fluorescence bands of uranium salts, interesting evidence of the existence of atomic magnetic fields of the order 10^8 gauss.

Hence, from all the foregoing, which could be greatly elaborated, it seems that there is much and varied evidence in favor of the assumption that atoms have very powerful magnetic fields, due, presumably, to orbital revolutions of electrons.

Of course no one claims that more than a mere beginning has been made in the solution of the problem of the atom, but there is abundant evidence from many sources that this beginning is real.

W. J. Humphreys

U. S. Weather Bureau,
Washington, D. C.

KENTUCKY AS AN OIL STATE

At the present writing (June, 1917) Kentucky stands in the limelight as a prospective oil state. Due to the fact that the Irvine District of Estill County has been extended over a large area together with the greatly renewed activity in the older Kentucky fields, operators are now turning their attention to the state as a whole. This is particularly true of oil men from the Mid-continent Field. So it appears that the latter part of this year and the early months of 1918 will forever settle the question as to the state's potential rank in the production of petroleum and natural gas. Test wells are to be drilled in nearly every county in the state and the most modern applications of petroleum geology are being freely used. Up to the present time most of the "wild cat" work has progressed only to the mapping or leasing state, but the high standing of the companies interested is a good indicator of the developments that undoubtedly will follow.

There are four important geological factors that are always met in the search for new oil fields. When all of them are found to work in harmony great fields, like those of Oklahoma, Kansas and Texas or those of Pennsylvania, Ohio and West Virginia, are the result. Geological "structure," such as anticlines, domes, etc., constitute only one of these factors. A large number of structures do not produce oil or gas. They may or may not produce salt water. Furthermore, they may lie in what would be considered favorable regions. In such cases the detail which may have been expended in mapping them is of no avail. Such conditions result from failure of one or more of the three other factors, namely either (1) there is no open "sand" or other porous medium under the structure to serve as a retainer for oil and gas, or (2) there has never been present any salt water or other water in the sand to serve as a concentrating factor; that is, no gathering of oil and gas from a disseminated state to a commercial body; or (3) there is an absence of petroliferous shale or other fossil-bearing rocks that produce oil in a disseminated form.

Now the future of Kentucky as an oil state depends on the four factors above mentioned: (1) structure, (2) sand, (3) water, (4) original oil. There can be no question about the state having three of the above points in its favor, namely, (1) structure, (2) water, (3) original oil. There are numerous favorable structural conditions in various counties of the state. The rocks contain plenty of water and there are some good beds of oil-bearing shale. The Devonian Black Shale is particularly a splendid carrier of original oil. The fourth factor is, however, as yet to be proved of sufficient importance to place Kentucky in high rank as an oil state; namely, "sand." In great oil fields there are large bodies of sand or retaining reservoirs in close proximity to beds of oil-bearing shale There are frequently several such "sands" in the geological column in close relationships to oil-shale beds.

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[12] *Ann. der Phys.*, 39, 789, 1912.

In Kentucky the "sands" or "porous beds" near the Devonian Oil Shale are carrying most of the oil so far discovered. In Wayne County these sands lie in the Waverly series above the Black Shale, but in other districts the oil is held below the shale in porous beds of limestone. This is true of the oil fields at Irvine, Cannel City, Campton, Menefee County and other districts of eastern Kentucky. In the coal basins of eastern Kentucky and western Kentucky there are a large number of beds of porous quartz sandstone; they lie in the Chester and Pennsylvania series, but in connection with these sandstone beds, oil shales must be proved to exist in order that any particular structure may be found productive. If, for instance, a bed of oil shale like the Devonian Black Shale could be found just above or below the Big Clifty Sandstone at the base of the Chester, then an anticline containing these beds at sufficient depth would most certainly make a big oil and gas field like those of Oklahoma; but it so happens that in a great many cases in Kentucky the oil shales do not lie near dependable porous reservoir rocks or else the porous sandstones in the higher portion of the geological column, such as those above enumerated, do not have near them any great amount of typical oil shale.

In conclusion the writer desires to state it as his opinion that Kentucky is not to rank high as an oil state in comparison with many other areas in the United States where the four factors work in harmony and there are numerous porous sands near beds of oil shale; however, the writer wishes to emphasize the probability that a number of structures in Kentucky will find the four factors working together and will furnish new oil pools that will be highly valuable to those who are fortunate enough to discover them.

Careful studies by geologists working in the state will serve to gather a great deal of important information in addition to merely mapping suitable structural conditions in any particular locality.

JAMES H. GARDNER

TULSA, OKLA.

OVERWINTERING OF THE APPLE-SCAB FUNGUS

THOUGH it is generally known that the scab disease of the apple, caused by the fungus *Venturia inequalis,* sometimes attacks the young twigs of susceptible varieties of the apple, yet not much has been published on this phase of the disease in North America.

Morse and Darrows[1] show that the conidia of this fungus survived the winter on apple twigs and germinated readily in the spring. They found no evidence, however, that the mycelium exists during the winter as a living stroma and produces conidia in the spring.

A review of the literature of this subject is given by Morse and Darrows. Wallace[2] also reviews the literature of the persistence of the stroma on the twigs and the hibernation of conidia and is convinced that twig infection is not of common occurrence and that conidia can not withstand winter temperatures

The writer's attention was first called to scab disease on the young shoots of the apple in the fall of 1915, when a number of badly diseased twigs of a McIntosh apple tree were sent to the college for determination. They were forwarded by Dr. E. W. Henderson, of Mansonville, in this province. The twigs were defoliated for several inches from the tips, and the leaves that remained below showed a very severe attack of scab. The twigs were severely injured, many of them being in a dying condition. The bark was studded with the pustules of the scab disease and abundant conidia were present. Another collection was sent by Dr. Henderson on request a few weeks later. Many of the twigs were now dead and few conidia remained.

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[1] *Phytopath.*, 3: 265, October, 1913.

[2] *Bull. Cornell*, 335, 193.

Another collection of diseased twigs was received about the first of April from Professor Shaw, collected at Truro Agricultural College, N. S., also from a McIntosh tree. Many of these twigs were killed back several inches and in the dead and also in the living bark abundant pustules of the scab were present. The affected twigs showed the characteristics described by Morse and Darrows. The bark was more or less thickly studded with light brown spots which examination showed to be blister-like areas due to the death and pushing out of the epidermis of the twigs. Many of these light-brown areas were roundish or oval with a dark center. A number, however, lacked the dark central area. Pieces of the diseased bark were removed, embedded in paraffin and sectioned, and the sections and diseased twigs examined. A well-developed stroma was present, and many conidia beneath the raised epidermis. The dark center was composed chiefly of the conidiophores of the fungus, the exposed conidia having fallen away.

Dr. Henderson and Professor Shaw were asked to forward diseased twigs collected about blossoming time, and both generously responded. The collection from Professor Shaw was received about the first of June. A few inches of the tips of some of these twigs were dead, but the bark of the living parts and of the living twigs contained many scattered postules of the apple scab actively producing conidia, the pustules being olive green from the abundant conidia. The dead parts of the twigs were thickly covered with scab pustules of the previous season, but the stroma was dead or not producing conidia.

The fresh conidia were placed in hanging drops of distillated water and they germinated as freely and vigorously as conidia obtained a short time later from the young leaves of an apple in the orchard.

Pieces of the bark containing living pustules were fixed, embedded in paraffin and sectioned. The stroma was very well developed, reaching a maximum thickness of 200 microns, while the maximum thickness of the stroma on the fruit was about 55 microns. It was also evident that the stroma was actively producing conidia at the time of fixation.

Mr. A. G. Turney[3] describes the scab as being troublesome in the twigs of susceptible varieties and states that in one orchard all the twigs of the previous year's growth of the Fameuse were covered with scab spots. He also found the amount of scab on the fruit was much reduced by trimming off the diseased twigs early in the spring He had previously failed to control scab in this orchard by spraying alone. However, he does not claim the results were entirely due to the spraying. He states in a letter to the writer that the scab is quite common in the coastal regions as a twig infestation, and it may be found also in almost any orchard inland, but rarely so bad as to be a serious hindrance to growth.

Professor Shaw in a letter to the writer states that he found severe twig injury from scab in several different regions in Nova Scotia. The twigs collected at Mansonville, Quebec, at blossoming time by Dr. Henderson did not show any living pustules, but as not many of them had been cut back into the living wood the negative evidence was not satisfactory.

The twigs that had been received from Truro, N. S., about the first of April were left about eight weeks in the laboratory under ordinary conditions. Conidia were then taken from the scabbed areas and were tested in hanging drops of distilled water for germination. A small percentage was found to germinate. A second test gave the same result. The spores were taken from beneath the blistered bark, so that they had a certain amount of protection from the cold and from drying.

The writer is convinced from these experiments and observations that in certain regions near the coast apple scab may winter on the twigs of susceptible varieties such as Fameuse and McIntosh as a dormant stroma and produce abundant conidia in the spring. It also confirms Morse and Darrow's conclusion that under certain conditions and with certain varieties of apples diseased twigs and water sprouts may be an important factor in the propagation and spread of the disease.

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[3] Report of the Horticulturist, Province of New Brunswick, p. 100, 1915.

Mr. J. S. Dash when a senior student at Macdonald College devoted some time to the study of apple scab and the results of his studies were embodied in an unpublished paper now in the college library. He collected scabby apples early in the spring that had lain under the snow all winter and found that about five to ten per cent. of the conidia germinated.

On November 27 of the present year the writer collected scabby apples that had lain under the trees after their fall without protection of any kind. During late fall and early winter the temperature fell below the freezing point fifteen times, rising above during the day. There were two periods of severe frost followed by mild weather, the minimum temperature of the first being 11° F. and of the second on November 26 being 1° F. Conidia were abundant on the scab spots and these were placed in hanging drops of distilled water. The spores germinated freely and vigorously and in twenty-four hours showed many germ tubes over 100 microns in length. By count of the spores present in a number of microscopic fields in several hanging drops it was found that over 26 per cent. had germinated. Only those with well-developed germ tubes were counted. The conidia were examined immediately after being placed in the distilled water, and there could be no doubt whatever that the germ tubes had developed while in the water.

It would seem from these observations that the conidia are more resistant to low temperatures than is generally supposed. As material is available it is hoped to carry on further experiments along this line during the winter and spring.

W. P. Fraser

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SCIENTIFIC EVENTS

BARON DAIROKU KIKUCHI

Baron Dairoku Kikuchi died suddenly at his villa at Chigasaki, Japan, on August 19. Baron Kikuchi was graduated from the University of Cambridge, England, with the rank of "wrangler." He became professor of mathematics in the Imperial University at Tokyo and later its president. He was for a time the Imperial Minister of Education and a member of the Emperor's Privy Council at the time of his death.

He was active and influential in the organization of the Japanese National Academy of Sciences, the National Educational Association and in the development of all the scientific and educational interests of the empire. He was the author of many contributions to scientific journals and several books, including a notable volume on "Japanese Education," consisting of a series of lectures delivered at the University of London in 1907. Baron Kikuchi made several visits to the United States, lecturing in our principal cities and at several of our leading institutions of learning. He was looking forward to another visit to America in the very near future, and his many friends in this country will learn of his death with profound regret.

THE PRODUCTION OF POTASH IN THE UNITED STATES

More potash has been produced during the first six months of 1917 than was made during the entire year 1916. The reports received by the United States Geological Survey, Department of the Interior, have been reduced to terms of the commercial unit commonly used to measure the available or water-soluble potash (K_2O) in the product, and only material actually sold by the producer during this period is included. The weight of the materials handled was therefore much greater than represented by these figures.

This table includes practically all potash produced.

The Nebraska alkali lakes still lead, having yielded about one third the entire production. There are now at least four important operators in this field.

SUMMARY OF THE PRODUCTION OF POTASH IN THE UNITED STATES, JANUARY TO JUNE (INCLUSIVE), 1917

Source	Available Potash (K_2O)	Value at Point of Shipment
Natural salts or brines	7,749	$2,808,240
Alunite and dust from cement mills and blast furnaces	1,867	746,576
Kelp	2,143	1,348,095
Distillery slop, wool washings and miscellaneous industrial wastes	2,153	876,714
Wood ashes	111[1]	84,414
	14,023	$5,864,039

The production from Searles Lake, Calif., would undoubtedly be materially assisted by passage of the legislation now before the House of Representatives dealing with the leasing of potash-bearing lands. Continued uncertainty as to the status of titles to this property has hampered development of this important deposit.

No production is reported from feldspar or other silicate rocks, but considerable quantities of potash salts and potash-bearing fertilizers were obtained from the dusts in cement mills and blast furnaces.

The production from kelp was about 15 per cent. of the total, as it was in 1916.

Potash from distillery slop and other organic sources made 15 per cent. or more of the total.

The production of potash from wood ashes, including "first sorts," "pearlash" and other grades, is supposed to have been much greater than it was in 1916, but reports from these producers have been much delayed and the figures obtained thus far are probably not representative. The potash made from wood ashes thus far reported amounted to 222 tons, which is assumed to average at least 50 per cent. K_2O. This is perhaps too low, but definite information as to the grade of this material is difficult to obtain.

The prices quoted range from $3.50 to $6 a unit, a unit meaning 1 per cent. of potash (K_2O) in a ton of the material as marketed—that is, a product carrying 25 per cent. K_2O may be sold at $4 a unit, which would be $100 a ton for the material marketed.

The figures given seem to indicate that the production for 1917 will exceed 25,000 tons of potash (K_2O) or two and one half times that made in 1916. This is about 10 per cent. of the average normal yearly consumption of the country before the war, showing the need of further stimulating domestic production of potash.

THE MUSEUM OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND

THE annual report of the Conservator of the Museum of the Royal College of Surgeons of England, as abstracted in the *British Medical Journal*, contains a review of work done in the museum. Professor Keith states that besides routine investigations carried on by the staff, Dr. Colin Mackenzie had not only continued his inquiries into the anatomy and physiology of Australian mammals, but acting also as a member of the honorary staff at the Military Orthopedic Hospital, Shepherd's Bush, had found it advantageous to combine his work at the hospital with a research, bearing on his cases, in the workrooms of the College. The comparative anatomy of the muscles of the forearm appears to throw much light on their exact significance in man which may prove of value in surgery. The specimens of bone grafts which accompanied Major E. W. Hey Groves's Jacksonian Prize Essay are distinguished in the report as of particular merit. Many preparations of value have been added to the pathological, teratological, and particularly to the anthropological series; the latter include prehistoric human bones unearthed during trenching operations, not only in home drill but also at the front. The four complete skeletons of gorillas, each representing a different stage of growth, collected in the German Cameroons, and generously purchased and presented to the museum by Sir John Bland-Sutton, will provide an opportunity of illustrating various stages in the growth of that anthropoid which, in a structural sense, is man's nearest relation. Among drawings acquired by the museum is a sketch made for John Hunter representing a duck which had partially assumed the plumage of a drake, a subject in which he was greatly interested. Lastly, we may add that the executors of Dr. Robert Roxburgh have presented the original mechanical spray apparatus which Lord Lister employed in the Royal Infirmary, Edinburgh, and exhibited at the Plymouth meeting of the British Medical Association in 1871 during the course of his address in surgery. It had two nozzles attached to independent caoutchouc tubes, furnishing large clouds of spray, that could be directed, if necessary, to opposite sides of the part operated on. Dr Roxburgh was Lister's last house-surgeon at the Royal Infirmary. Lister went to King's College, London, to fill the chair of clinical surgery in succession to Sir William Fergusson in 1877.

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[1] Only 25 reports of production from wood ashes have come in, some of the larger producers not having made returns.

THE MAYO FOUNDATION AND THE UNIVERSITY OF MINNESOTA

THE board of regents of the University of Minnesota have ratified by unanimous vote the permanent agreement making the Mayo Foundation at Rochester the absolute property of the university, to be used perpetually for higher medical education and research. Securities totaling $1,650,345, representing the fortunes of Drs. William J. and Charles Mayo, were turned over to the university.

"We turn over to the regents the bulk of our savings of a generation as an outright gift," said Dr. William J. Mayo, who is a member of the board of regents, but who did not vote on the proposal. "The money came from the people, and we feel it should return to the people—a continuing fund that shall serve this state for generations to come."

Expenses of the foundation will be paid by the Drs. Mayo until a fund of $2,000,000 has accumulated. Thereafter the income from the fund will maintain it.

The foundation has been affiliated with the university for two years, which was agreed upon as a trial period. Under the final agreement the headquarters of the foundation can be moved from Rochester to another point in the state after twenty-eight years. Ten per cent. of the yearly income may be expended outside the state and another ten per cent. may be used to investigate epidemics inside and outside the state.

It was announced that one of the Mayos would go to France with recruits next year and that they would take turns there until the end of the war.

SCIENTIFIC NOTES AND NEWS

M. PAUL PAINLEVÉ has been chosen to be premier of the French Republic. M. Painlevé has been professor of mathematics in the University of Paris and of mechanics at the Paris Polytechnic School.

M. G. FAYET, assistant director of the Nice Observatory, has been appointed director in succession to the late General Bassot.

DR. R. W. WOOD, professor of physics in the Johns Hopkins University, is now in France engaged in scientific research in cooperation with members of the Paris Academy of Sciences. Dr. Wood left about three weeks ago, following the receipt of a cablegram from Premier Ribot offering him the tentative ranking of major in the French army.

DR. RAYMOND PEARL, biologist and head of the department of biology of the Maine Agricultural Experiment Station, has been granted leave of absence from that institution for the duration of the war, to take charge of the statistical department of the United States Food Administration. He left the experiment station for Washington early in June, accompanied by Dr. Frank M. Surface, biologist of the Maine Station, who was also granted leave of absence for the same work. The following are associated, for the duration of the war, with Dr. Pearl in the statistical work of the Food Administration:

Dr. H. S. Jennings, The Johns Hopkins University.
Dr. W. E. Kellicott, Goucher College.
Dr. H. R. Willard, University of Maine.
Mr. John Rice Miner, Maine Agricultural Experiment Station.

DR. A. W. DOX, for the past seven years chief of the section of chemistry of the Iowa Agricultural Experiment Station, has been granted leave of absence to accept a commission as captain in the food division of the Sanitary Corps of the National Army.

Dr. Frank C. Gephart, chemist of the Russell Sage Institute of Pathology, has received a commission as captain in the Sanitary Corps, United States National Army, with headquarters at the Surgeon General's office, Washington, D. C.

Dr. H. R. Glascock has resigned from the professorship of biology at De Pauw University and will engage in service with the Medical Corps.

The War Department has refused to accept the resignation of Dr. James W. Inches, health officer of Detroit, from the Detroit College of Medicine and Surgery Base Hospital No. 36, in order to allow him to accept an appointment by the American Red Cross as one of the fifteen commissioned specialists to study conditions abroad.

B. K. Coghlan has resigned as associate professor of highway engineering at the Agricultural and Mechanical College of Texas. He is captain in the Engineer Officers' Reserve Corps and has been ordered to Ft. Leavenworth. E. O. Francisco, who was assistant professor of civil engineering at the college during the last session, has been commissioned a second lieutenant in the Engineer Officers' Reserve Corps and has also been ordered to Ft. Leavenworth.

Dr. James D. Maddrill, of the Travelers Insurance Company, has become actuary of the bureau of efficiency and economy at Washington. Dr. Maddrill has been in charge of the International Geodetic Observatory at Ukiah, Calif., and instructor in insurance mathematics at the University of California. His position at Washington will call for the preparation of a plan for pensioning all the civil employees of the government, numbering more than 300,000, and for other calculations of an actuarial and statistical nature.

Dr. Lewis R. Harris has been appointed director of the Bureau of Preventable Diseases of the New York City Health Department to succeed Dr. Bertram Waters, who has resigned from the Department of Health to resume his private practise.

Mr. L. E. Warren, for eight years associate chemist in the chemical laboratory of the American Medical Association, has resigned his position to take charge of the research laboratories of the New York plant of Wm. R. Warner & Co.

Dr. Maurice G. Mehl, former head of the department of geology and director of the school of engineering and geology at the University of Oklahoma, has given up his work in that institution and will for the present give his time to a study of the oil and gas conditions of Oklahoma and Kansas.

Professor Junius Henderson, of the University of Colorado, has recently returned from an expedition to northern Wyoming. The collections obtained consist principally of land shells and fossils.

Professor C. C. Nutting has recently returned from Barbados and other West Indian Islands, where he has been looking over the ground in preparation for a party of zoologists who propose to visit that region next spring. This expedition will be under the auspices of the graduate college of the State University of Iowa, and will consist of instructors and graduate students in zoology; and the plan is to select some suitable point as a base of operations for the exploration and study of typical coral reefs. Dredging will be carried on, probably to a depth of two hundred fathoms, and a zoological laboratory will be established on shore. In his preliminary trip Professor Nutting visited the Islands of St. Thomas, St. Croix, St. Kitts, Antigua, Dominica, Martinique, St. Lucia and Barbados. The proposed expedition will probably make either Barbados or Antigua the base for their operations.

The Norwegian explorer, Roald Amundsen, is at present preparing an Arctic expedition, which will start next March or April. A new expedition ship has been built, replete with every modern requirement in the way of technical equipment. Amundsen intends to take an aeroplane on board to be used for reconnoitering in the Arctic regions.

LECTURERS before the graduate summer quarter in medicine of the University of Illinois included Dr. Sidney I. Kornhauser, assistant professor of zoology in the Northwestern University, on "Sex determination and the nature of secondary sexual characteristics"; Dr. Reuben M. Strong, associate professor of anatomy in the Vanderbilt University, on "Adaptation in bone architecture"; Dr. Orville H. Brown, of Phœnix, Arizona, on "Asthma," and Dr. Addison Gulick, assistant professor of physiology in the University of Missouri, on "Over-feeding and the calorie problem in human metabolism."

WE learn from *Nature* that the fifth annual meeting of the Indian Science Congress will be held in Lahore on January 9 to 12 next, under the presidency of Dr. G. T. Walker, F.R.S., Director-General of Observatories. The sectional presidents will be: Dr. L. Coleman (Agriculture), Dr. Wali Mahomed (Physics and Mathematics), Dr. G. J. Fowler (Chemistry), Dr. Choudhuri (Zoology and Ethnology), Mr. R. S. Hole (Botany), Mr. E. S. Pinfold (Geology). Dr. J. L. Simonsen, of the Presidency College, Madras, is the honorary secretary for the meeting.

SECOND LIEUT. EDWARD OSLER, R.A., only son of Sir William Osler, died in England on August 31. He was wounded recently while on active duty in France, and had been taken to England for treatment.

PROFESSOR S. B. KELLEHER, Erasmus Smith professor of mathematics in the University of Dublin, died on August 18.

IT is reported from London that A. Chester Beatty, a Columbia alumnus, has offered his London house as an American Officers' Hospital under the supervision of the Columbia Hospital Unit. The Columbia Unit is under the direction of Dr. George E. Brewer, of the College of Physicians and Surgeons and the Presbyterian Hospital. The unit is now in England. It is also stated that American medical officers will take charge of the military hospitals at Manchester, Salford, Liverpool, Leeds, Birmingham, and Cardiff, and the civil medical practitioners at present in charge of those hospitals will be informed that their services are no longer required. It is understood that the reason for the change is that the services of the civilian doctors are required for the needs of the population, who have been inadequately served, owing to the attendance of so many physicians at the military hospitals.

A CHEMICAL INDUSTRIES BUREAU is in course of formation in Sweden, the object of which will be to bring together the Swedish chemical industrial interests.

THE Tootal Broadhurst Lee Company of Great Britain announces that "assured of the importance of research and education in the struggle for the world's trade, the directors have decided to set aside £10,000 a year for five years for this purpose." The provisional committee on research and education for the cotton industry will, at the close of the current holiday season, issue a prospectus of the new government-incepted and aided organization. This definite industrial research federation of the cotton trade will be followed by the establishment of institutes and laboratories. A provisional committee to organize textile research associations in the woollen trade has been formed.

THE *Proceedings* of the Nineteenth International Congress of Americanists, held at Washington, December 27–31, 1915, has just made its appearance. It is a handsome royal octavo volume of 717 pages, with many illustrations, and in addition to the proceedings of the congress includes ninety articles on American archeology, ethnology, folklore and tradition, history, linguistics, and physical anthropology. The work was prepared by Dr. A. Hrdlička, of the United States National Museum, who was general secretary of the congress, and edited by Mr. F. W. Hodge, of the Bureau of American Ethnology.

BY the will of Julian A. Hellman, a residuary fund, which may amount to $100,000, is created to be used by Mount Sinai Hospital for the purpose of cancer research work.

Free public lectures of the New York Botanical Garden are being delivered in the Lecture Hall of the Museum Building of the Garden, Bronx Park, on Saturday afternoons, at four o'clock, as follows:

September 1. "Collecting fungi in the Catskills," by Dr. W. A. Murrill.

September 8. "The origin and history of soils," by Dr. A. Hollick.

September 15. "Growing fresh vegetables in the back yard," by Mr. H. G. Parsons.

September 22. "Some botanical features of northern Cape Breton," by Dr. G. E. Nichols

(Exhibition of Dahlias, September 22 and 23)

September 29. "Growing nut trees," by Dr. W. C. Deming.

October 6. "Autumn coloration," by Dr. A. B. Stout.

October 13. "The relation of forests to water supply," by Dr. G. C. Fisher.

(Catskill Aqueduct Celebration Lecture)

October 20. "Fall planting and winter protection," by Mr. G. V. Nash.

The Paris Academy of Sciences has decided to establish a National Physical and Mechanical Laboratory for the purpose of scientific research, directed in a marked degree to the benefit and use of the industries. The laboratory will be controlled by a council, of which half the members will be nominated by the academy, one fourth by the state department, and the remainder by the chief industrial associations. The executive control will be in the hands of a small technical committee. Existing laboratories engaged in similar work will be affiliated with the National Laboratory, and will work in close relationship with it. Substantial funds are to be provided for working expenses and for the assistance of the affiliated institutions.

At the request of the government, the council of the British Medical Association has submitted the following plan for the creation of the Ministry of Health: "That a ministry of health should be created to take over from existing government departments such duties as are concerned with the health of the community, and to deal with those duties only; that the administrative functions of the ministry should be carried out by a board presided over by a minister of cabinet rank; that the country be divided into suitable administrative areas under local administrative health centers consisting of representatives (*a*) of the rating authorities; (*b*) of the education authorities; (*c*) of the persons contributing to a scheme of health insurance (including employers of labor); (*d*) the medical profession; (*e*) public hospitals; (*f*) dentists; (*g*) pharmacists, and (*h*) nurses; that the principal medical officers of each center should be two, of equal status, one representing the clinical side (chief clinical officer) and the other the preventive side of medicine (medical officer of health); that for each area, hospitals, clinics or treatment centers should be recognized or established at which persons entitled to treatment under the public scheme should be able to obtain institutional, consultative or specialist services on the recommendation of their medical attendant." The meeting passed a resolution by an overwhelming majority in favor of the appointment of a ministry of health.

UNIVERSITY AND EDUCATIONAL NEWS

Brown University receives $100,000 for a teachers' fund and $4,000 for the purchase of volumes of American poetry by the will of the late Samuel C. Eastman, of Concord, N. H. The Concord Public Library is given $2,000, the New Hampshire Historical Society $4,000, and $3,000 will go to charity. One half the residue of the estate is willed to Brown University, one fourth to the Concord Public Library, and one fourth to the New Hampshire Historical Society.

The University of Maine and Bates and Colby Colleges have postponed their opening for about a month to allow students to continue their work on farms and in industries.

Professor William A. Schaper, of the department of political science of the University of Minnesota, has been dismissed, following an investigation of the attitude on the war of members of the faculty. Professor Schaper denies that he has been disloyal.

Dr. William Allen Neilson, professor of English at Harvard University, has been elected president of Smith College. He succeeds Dr. Marion L. Burton, who has become president of the University of Minnesota.

James C. Nagle has been appointed dean of engineering and professor of civil engineering in the Agricultural and Mechanical College of Texas, succeeding D. W. Spence whose death occurred in June.

Professor W. S. Franklin, formerly of Lehigh University, has accepted a position as special lecturer and teacher at the Massachusetts Institute of Technology, partly in the department of physics and partly in the department of electrical engineering. Professor Franklin requests his correspondents to note his new address.

Dr. C. H. Shattuck, for the past eight years head of the department of forestry, University of Idaho, has accepted the position as professor of forestry with the University of California.

Dr. Wright A. Gardner, formerly associate professor of plant physiology in the University of Idaho, has been appointed professor of plant physiology and head of the department of botany in the Alabama Polytechnic Institute.

Dr. Alfred H. W. Povah, formerly instructor in botany in the University of Michigan, has been appointed special lecturer in forest mycology in The New York State College of Forestry at Syracuse University.

Mr. Ralph Hubbard, formerly of Cornell University, has been appointed assistant in the museum and zoological department of the University of Colorado.

Mr. Samuel Wood Geiser, formerly professor of biology and geology in Guilford College, has been appointed professor of biology in Upper Iowa University.

At the University of Oregon, Charles H. Edmondson, Ph.D. (Iowa, '06), assistant professor of zoology, and Albert E. Caswell, Ph.D., (Stanford, '11), assistant professor of physics, have been promoted to full professorships, and Raymond H. Wheeler, Ph.D. (Clark, '15), instructor in psychology, has been made an assistant professor. During the present summer Dr. Edmondson has been studying the clams of the North Pacific Coast with a view to their conservation for food purposes.

Dr. Lloyd Balderston, of Ridgway, Pa., has been appointed professor of leather chemistry and technology in the college of agriculture of the Tohoku Imperial University, at Sapporo, Japan.

DISCUSSION AND CORRESPONDENCE

ON THE "RAWNESS" OF SUBSOILS

In the interest of accuracy the writer feels impelled to call the attention of investigators of soils to some facts with reference to the infertility of subsoils which do not seem to be generally appreciated. This statement is called forth at this time by the recent paper of Alway, McDole and Rost[1]; the observations upon which it is based are of long standing but have not been described because of matters of greater importance which have intervened to prevent such description. The authors just cited call attention to the characteristic sterility of subsoils of humid regions with which every student of soils is of course familiar. No one can deny that fact. They go on, however, to cite Hilgard, and Wohltmann who had visited California, to the effect that subsoils of arid regions are not sterile, but serve just as well or better than surface soils in that region for the support of plant life whether the latter be of legume or non-legume order.

Neither Hilgard's nor Wohltmann's observations are in full accord with mine except in certain cases which I shall refer to below. In studying the soil conditions of the Great Valley of California and particularly those of the citrus and alfalfa growing districts, I have repeatedly observed the vegetation, natural or planted, which is to be found on the freshly graded fields. Grading is done, of course, in preparation of soils for irrigation and may result frequently in the removal of several inches to two, three or even more feet of surface soil in order that a level field may be produced. This is particularly striking in the case of the well-known and, on genetic grounds, highly interesting "hog wallow" lands which comprise very large areas of the Sacramento and San Joaquin Valleys. On the citrus lands either barley or alfalfa may be grown for a year or more in the preparation of the soil for the citrus trees. Wherever barley is sown, it is always possible to distinguish between the spots in the field from which the surface soil has been removed and those which still consist of surface soil. On the latter the barley looks as nearly normal as the given soil type will permit it, whereas on the former the barley growth, if it is at all visible, is stunted and yellow and frequently does not live though the growing season. Only in places where considerable surface soil has in the process of grading become admixed with the subsoil, have I ever noted an approach to good barley growth.

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[1] *Soil Science*, Vol. 3, p. 9, January, 1917.

In the case of alfalfa, however, I can only recall one or two instances of failure to grow as well on the raw subsoil as on the surface soil. The difference between the behavior of barley and alfalfa on the subsoil in question is probably to be ascribed to the paucity in *available nitrogen* which is known to characterize subsoils. Under such conditions, barley can, at best, only make very poor growth, whereas the alfalfa, if inoculated, is independent of the available nitrogen supply in the soil. It should be added that with the admixture to some extent of surface soil with the subsoil in the process of grading a large enough number of *B radicicola* is introduced all through the graded land to insure to alfalfa the necessary nitrogen for its growth, an advantage which that legume in common with others does not share with non-legumes. The case noted in Berkeley by Hilgard regarding which the latter is quoted by Alway, McDole and Rost, is undoubtedly that of an observation on the campus of the University of California, on the surface of which there has been so much filling and cutting for a number of years as to render questionable in any instance the real origin of the soil or subsoil observed. In my knowledge of the campus, I have known the excavation of subsoil material which had not long before been surface soil to result in bringing it back to its original condition again. We should not expect such material to be as inert and as unresponsive in growing non-legumes as real subsoil material. Arguing, however, from direct observation, I should like to add that I have frequently observed on the same campus, in places in which deep excavations were accomplished, that very little vegetation appeared for a year or more after the true subsoil material had been opened to air, light and the sun's warmth, as well as to the effects of inoculation by dust from surface soils. Such vegetation as did establish itself consisted almost invariably of bur clover. *Medicago denticulata.* When other plants were present, they were usually found to be alfilaria, *Erodium cicutarium,* a plant which is most commonly associated with bur clover on California soils and which probably profits by the nitrogen fixed by the clover. The bur clover plants found on such sterile subsoil material as is above described have always been found to be abundantly supplied with nodules.

The writer's observations lead him to believe, therefore, that subsoils of arid regions are nearly if not quite as raw as those of humid regions and that despite the great differences between the two in many respects, the first will not support plant growth to a much greater extent than the latter. The close resemblance which obtains between our subsoils and our surface soils, and which does not characterize the soils and subsoils of humid regions, appears, therefore, to be no index to the productivity of our subsoils. I should judge, in fact, from the statements of Alway, McDole and Rost, that the California subsoils are not superior to the Nebraska subsoils in any respect from the point of view here under consideration. As above pointed out, it seems fairly certain that the chief cause of the rawness of subsoils is the lack of available nitrogen in them for the support of the non-legume.

This deduction seems to be supported by the fact that legumes when inoculated will grow in the raw subsoils, whereas the non-legumes will not. That legumes will not grow on subsoils of humid regions as is claimed by Alway, McDole and Rost is not, so far as I am aware, proved. In any case their claim that the failure of such inoculated legumes to develop on humid subsoils "is to be attributed to a lack of availability of the phosphoric acid or of the potash or of both," appears to be an assumption which is unsupported by fact. Data on the content of water-soluble phosphoric acid and potash in subsoils of humid regions give no indication, so far as the writer is aware, of a paucity in those respects which would at all account for the total failure to develop manifested by the inoculated legume plants mentioned above. If inoculated legume seeds do fail to develop on humid subsoils, such failure must be accounted for, it would seem, on other grounds than those proposed by Alway, McDole and Rost.

It may also be added here that Hilgard's explanation for the "rawness" of subsoils is probably neither correct nor necessary. One is not obliged to assume a washing down of fine clay and silt particles from the soil into the subsoil to account for very imperfect aeration in the latter. Indeed, the sands of nearly uniform texture for several feet in depth, which are common in California, exhibit similar rawness in the subsoil, to that of the loams and clays which are underlaid by almost impenetrable silty clays.

SUMMARY

1. Subsoils of arid regions are certainly no less "raw" than those of semi-arid regions, and probably only slightly less so than those of humid regions.

2. If, as seems as yet unproved, inoculated legume seeds fail to develop on humid subsoil material, such failure can not justifiably be attributed as is done by Alway, McDole and Rost, to a lack of available phosphoric acid and potash.

3. A lack of available nitrogen probably is sufficient to account for rawness of subsoils.

4. The poor aeration of subsoils which indirectly results in their rawness, may be accounted for more simply than by Hilgard's explanation of the washing down of fine particles into the subsoil, which prevents proper aeration.

Chas. B. Lipman

University of California

NORTHERN LIGHTS

To the Editor of Science: Readers of Science will be interested to note the following observation of the northern lights. We noted them here on the evening of August 9 at about 8:45. They extended across the sky from northwest to east by northeast. They appeared as streaks, not very wide, and there was little or no flickering. A diffuse glow in the sky was more evident than the streaks. The night was clear and bright, so that this may account for the fact that they were not very prominent. They seemed to extend from 40° to 70° in height. At 9.35 P.M. they were still visible, but shortly after 10 there was no trace of them.

The northern lights, of which so many accounts were published in Science about this time last year, were observed here also, although I do not recall that any one reported the fact.

Thomas Byrd Magath

U. S. Bureau of Fisheries
Biological Station,
Fairport, Iowa

THE NEW MOON

To the Editor of Science: In making some computations last March about the occurrence of New Moon, an error of statement was discovered in the 9th edition of the Encyclopædia Britannica under "Calendar," Vol. IV., p. 594, and repeated in the 11th edition, Vol. IV., p. 993; it is also given in Barlow & Bryan's "Mathematical Astronomy," p. 215. The erroneous statement is that New Moon occurred on January 1 in 1 B.C. New Moon in January, 1 B.C., occurred on January 25, 12^h 26^m Jerusalem Mean Civil Time.

Otto Klotz

Dominion Observatory,
July 31, 1917

ERASMUS DARWIN AND BENJAMIN FRANKLIN

Extracts from two previously unpublished letters from Erasmus Darwin to Benjamin Franklin appeared in Science, June 2, 1916. Concerning one of these letters, Dr. L. Hussakof, the author of the article in which they appeared, wrote:

> It is addressed simply: "Dr. Franklin, America," and opens in the grandiloquent style of the time (1787) as follows:
>
> "*Dear Sir*, Whilst I am writing to a Philosopher & a Friend, I can scarcely forget that I am also writing to the greatest Statesman of the present, or perhaps of any century. . . ."

The following paragraph from Anna Seward's "Memoirs of the Life of Dr. Darwin," which appeared in 1804, throws an interesting sidelight on this letter:

> In allusion to (his) perpetual travelling, a gentleman once humorously directed a letter, "Dr. Darwin, upon the road." When himself wrote to Dr. Franklin, complimenting him on having united philosophy to modern science, he directed his letter merely thus, "Dr. Franklin, America"; and said he felt inclined to make a still more flattering superscription. "Dr. Franklin, the World." His letter reached the sage, who first disarmed the lightning of its fatal power, for the answer to it arrived, and was shown in the Darwinian circles; in which had been questioned the likelihood of Dr. Franklin ever receiving a letter of such general superscription as the whole western empire. Its safe arrival was amongst the triumphs of genius combined with exertion, "they make the world their country."

The other hitherto unpublished letter Dr. Hussakof says is "remarkable chiefly for one sentence near the end, which contains the amazing information that even as far back as that (1772), someone was puzzling over the idea of making a phonograph. 'I have heard,' writes Dr. Darwin, 'of somebody that attempted to make a speaking machine, pray was there any Truth in any such Reports?'"

Charles Darwin in Krause's "Life of Erasmus Darwin" (p. 120), says that a speaking machine was a favorite idea of his grandfather and for this end he invented a phonetic alphabet. Erasmus Darwin himself says in his "Temple of Nature" (1802), note No. 15:

> I have treated with greater confidence on the formation of articulate sounds, as I many years ago gave considerable attention to this subject for the purpose of improving shorthand; at that time I contrived a wooden mouth with lips of soft leather, and with a valve over the back part of it for nostrils, both which could be quickly opened or closed by the pressure of the fingers, the vocality was given by a silk ribbon about an inch long and a quarter of an inch wide stretched between two bits of smooth wood a little hollowed; so that when a gentle current of air from bellows was blown on the edge of the ribbon, it gave an agreeable tone, as it vibrated between the wooden sides, much like a human voice. This head pronounced the *p*, *b*, *m*, and the vowel *a*, with so great nicety as to deceive all who heard it unseen, when it pronounced mama, papa, map and pam; and had a most plaintive tone, when the lips were gradually closed.

All the other scientific subjects referred to by Darwin in these letters to Franklin are to be found discussed in one or more of Darwin's published works.

Dr. Darwin's prophetic insight along biological lines is well paralleled in another sphere in the following verses from his "Economy of Vegetation," Canto I:

> *Soon shall thy arm*, UNCONQUER'D STEAM! *afar*
> Drag the slow barge, or drive the rapid car;
> Or on wide-waving wings expanded bear
> The flying-chariot through the fields of air.

And again in a footnote:

> There is reason to believe it (steam) may in time be applied to the rowing of barges, and the moving of carriages along the road. As the specific levity of air is too great for the support of great burdens by balloons, there seems no probable method of flying conveniently but by the power of steam, or some other explosive material, which *another half century may probably discover.*

Finally, the following lines from the "Economy of Vegetation," Canto II, may have added interest to-day:

> *So, borne on sounding pinions to the* WEST,
> When Tyrant-Power had built his eagle nest;
> While from his eyry shriek'd the famish'd brood,
> Clenched their sharp claws, and champ'd their beaks for blood,
> Immortal FRANKLIN watch'd the callow crew,
> And stabb'd the struggling Vampires, ere they flew.

—The patriot-flame with quick contagion ran,
Hill lighted hill, and man electrified man;
Her heroes slain awhile Columbia mourn'd,
And crown'd with laurels Liberty return'd.

Lorande Loss Woodruff
Osborn Zoological Laboratory,
Yale University

SCIENTIFIC BOOKS

The Modern Milk Problem. By J. Scott MacNutt, Lecturer on Public Health Service, Massachusetts Institute of Technology. Macmillan Co, New York. 258 pages. Price $2.00

It would seem as if little that is new and interesting could be added to the multitudinous papers, circulars and books on milk that have appeared in recent years. The present book is a distinct acquisition, however, to the literature on the subject It is written in a clear style, and presented in such a way as to command the reader's attention throughout. While the various important phases of milk production are dealt with at some length, with due emphasis on the necessity of producing clean and safe milk, its most distinctive feature is its illuminating treatment of the economic factors which enter into the present-day milk problem.

Like Rosenau, the author believes that the producer is the victim of unfortunate circumstances, that he is little understood, and that as a rule he does not receive sufficient compensation for the capital which he has invested, the risks which he assumes, and the efforts and long hours which he devotes to his work. On the other hand, milk is milk to the consumer, and he will, with some exceptions of course, not protect himself against possible infection, but relies upon health authorities and medical or civic organizations to stand vigil for him.

One of the chief obstacles to a satisfactory solution of the milk problem is the lack of understanding and cooperation between the producer and those who are entrusted with the enactment and the enforcement of rules and regulations to protect the public. The State Agricultural Experiment Station is to-day doing much to instruct the farmer in the ways of economic milk production, a duty which no other agency can better perform.

Good and pure milk is a necessity. Aside from an inconsiderable amount of certified milk, milk is either good or bad, according to the author. So long as the ordinary producer stays within the minimum requirements of the law he has no incentive to increase the quality of his products. A premium paid on quality is one of the solutions of the good milk problem. Few producers are paid for the extra effort, and hence are content if they remain unmolested by the prosecutor.

The laboratory method of determining the quality of milk is, in the author's judgment, the most important, while inspection is of little merit, aside from the instruction to the producer in rational methods of clean milk production. The dairy score card also is of relatively little value, as it does not furnish a true index of the real quality of milk. Pasteurization, except for the highest grade, is necessary to protect the consumer. Grading and the laboratory examination are the most important single means of sanitary control, grading being the most important single factor in economic adjustment. Fair milk prices should be paid to both farmer and dealer on the basis of quality.

Several pages of well-chosen references are given, and the last 08 pages of the book are devoted to a comprehensive appendix in which valuable technical and statistical information is contained, as shown in the titles: Milk Statistics in the United States, Grading Systems of the Commission on Milk Standards, the North System, Costs and Prices, and Local Experiences and Investigations.

The book is designed to furnish information, in the author's words—"not merely for health officials and milk inspectors, but also for dairymen and city milk dealers, agricultural authorities, legislators charged with the framing of milk laws, inquiring consumers and members of organizations engaged in efforts to secure better milk supplies, physicians, and all others who are interested in the understanding and solution of the milk problem."

LEO F. RETTGER

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SPECIAL ARTICLES

GRAVITATIONAL REPULSION[1]

IN a paper entitled "Gravitation and Electrical Action" published by The Academy of Science of St. Louis, on July 28, 1916,[2] the following passage may be found:

> These results seem to indicate clearly that gravitational attraction between masses of matter depends upon their electrical potential due to electrical charges upon them.

Every working day of the present college year has been devoted to testing the validity of the above statement. All of the experimental results confirm this conclusion. No discordant results have been obtained. Not only was gravitational attraction diminished by charges of electricity upon the attracting bodies, when direct electrical action was wholly cut off by a metal shield, but gravitational attraction was converted into a repulsion which was greater than the normal attraction. On two days, when the influence machine, driven by a single-phase motor, was most highly efficient, the value of the gravitation constant was reduced by 250 and 300 per cent. of its maximum value. The maximum value of the gravitational attraction was evidently exerted when the potential of the attracting masses was zero absolute. The suspended masses were two spheres of lead, having a diameter of one inch, and distant from each other 91.5 cm. They were suspended on two untwisted threads of silk fibers, about 3.4 millimeters apart, and having a length of 179 cm. These silk threads were tied together at the top and hung around a pulley one inch in diameter. Below were two movable pulleys by means of which the distance between the silk threads could be adjusted to a parallel position. The large masses were spheres of lead having a diameter of 10 inches. They were mounted on blocks of wood having caster-wheels provided with roller bearings, which rested upon heavy sheets of hard rubber. The screen around the suspended masses was in part composed of wood, forming the top, bottom, and ends. The sides which faced the large masses each consisted of two sheets of heavy cardboard, outside of which was a sheet of metal. They were securely clamped to the top, bottom and ends of the enclosing shield by means of bars of wood and the joints were sealed by means of bees-wax, which was melted and run into the joints by means of a hot iron. The entire screen was then surrounded by another shield of metal. A layer of air about 1.5 cm. in thickness was thus formed between the two metal sheets on either side. A sheet of glass was also placed between each of the large masses and the metal sides of the shield. A box of metal filled with loose cotton-batting was placed in contact with the metal shield, alternating in position with the large masses. This was done in order to prevent as far as possible radiation from the northern sky from producing unbalanced convection currents in the air within the screen.

The large masses, the metal boxes contain- the cotton, and the metal screen were all in metallic connection with each other. All heat from the heating system of the building was cut off. The change in the position of the suspended masses was determined by means of a mirror, telescope and scale, observation being made through a narrow slit in the screen which was covered by a plate of photographic glass, sealed to the inner sheet of metal.

Three feet distant from the ends of the screen and the side opposite to the observing telescope was a line of insulated metal rods upon which was hung metal strips armed with 800 pins. At one end of this line of rods was a metal disc armed with 150 pins. Facing this disc was a duplicate disc attached to a line of rods hung upon silk cords, and leading to the influence machine in an adjoining room. There was no gap in the line of rods excepting between the two discs having 150 pins soldered to them. The rods carrying the 800 pins were directly connected with the shield and the large masses if a rapid change was desired.

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[1] Abstract of a paper to be published by the Academy of Science of St. Louis.

[2] *Trans. Acad. of Sc. of St. Louis*, XXIII., 4, p. 173.

When either the positive or the negative terminal of the machine was applied, the attraction of the large masses for the suspended masses was diminished. It sometimes happened that a slight increase was shown at first, until a condition of zero potential was reached. This was only observed when direct contact of the masses with the 800 pins was not made. It then required several hours for the decrease in gravitational attraction to reach a limit. Then when the other terminal was applied the masses slowly returned to the original position. If this deflection were due to heat effects causing convection currents of air within the shield, this return motion due to change in terminals would not occur.

On the occasion when the most marked effects were obtained, the decreasing effect took place very slowly, requiring five hours. There was no direct contact between the large masses and the 800 pins. The positive terminal had been applied. Negative electrons were being drained from the air surrounding the large masses and from the outer surface of these masses. Gravitational attraction had been reduced to zero. The negative terminal was then applied, and the masses were directly connected with the pin conductors by means of a metal rod. In five minutes (the time of a semi-vibration) the suspended masses had swayed back about half the angle over which they had slowly moved in the previous five hours. They then swayed back and oscillated to and fro, the mean of the extreme readings representing a decrease of 250 per cent. in the normal value of gravitational attraction between the masses. The arc of vibration during the next forty minutes was about equal to that due to normal attraction between the masses.

On the next morning the suspended masses were at rest, in a position which indicated that the large masses still repelled the suspended masses with a force about 2.5 times that of gravitational attraction. This position remained constant for two hours. The positive terminal was then applied and direct contact was made between the masses and the 800 pin conductors. During the next eighteen minutes the suspended masses swayed over an arc very nearly equal to that due to normal attraction. The attraction between the masses was increased. During the next twelve minutes they swayed backward over an arc about twice as great. The condition of zero potential had been passed. The force steadily decreased during the following ninety minutes. The gravitational attraction had then decreased to more than 300 per cent. of its maximum value. The negative terminal was then applied, and in two hours the reading was that at the beginning of the work of the previous day.

It is not necessary to continue an experiment of this kind throughout an entire day. Either terminal may be applied when the suspended masses are at rest, until an appreciable decrease in the gravitational attraction has become evident. A reversal of contacts of the machine may then be made and the masses will slowly sway back to their original position. This operation requires less than one hour. The evidence is as convincing as that produced by a feeble current of electricity upon a magnet suspended above it.

No attempt has been made in this work to obtain precise results. The aim has been to determine whether it would be proper to construct the much more expensive apparatus which will be needed, and which will permit the independent electrification of the suspended masses. Some results which have been obtained have aroused the suspicion that the "charges" on these masses varies from day to day, and that when their potential due to these charges is zero absolute, the electrification of the large masses will have no effect upon gravitational attraction. A modification of the apparatus used by Boys will be required.

The work here described has been done in a private laboratory in the second story of Ead's Hall, now occupied by the physics department of Washington University.

My thanks are due to the Carnegie Institution of Washington, for financial aid in this work.

Francis E. Nipher

THE CATALASE CONTENT OF LUMINOUS AND NON-LUMINOUS INSECTS COMPARED[1]

According to Dubois[2] and others the production of light by luminous organisms is an oxidative process. If this is true then it would seem that oxidation should be correspondingly more intense in luminous insects than in non-luminous insects. It has been shown that the catalase content of the different muscles of animals is proportional to the amount of oxidation in these muscles and that the catalase is increased or decreased under the same conditions under which oxidation is increased or decreased.[3] This and similar evidence would seem to indicate a close relationship between the catalase content of a tissue and the amount of oxidation in that tissue If oxidation is more intense in luminous than in non-luminous insects then the catalase content per unit of weight of luminous insects should be greater than that of non-luminous insects. The object of this investigation was to determine if the catalase content per unit of weight is greater in a luminous insect, such as the firefly (Photinus), than it is in non-luminous insects, such as moths, butterflies, honey-bees and bumblebees.

Method.—After the insect was weighed it was ground up with sand in a mortar. This ground material was added to 50 c.c. of hydrogen peroxide in a bottle and as the oxygen gas was liberated from the hydrogen peroxide by the catalase it was conducted through a rubber tube into an inverted burette previously filled with water. In this way the amount of oxygen liberated in ten minutes from 50 c.c. of hydrogen peroxide was collected. The volume of oxygen was read off directly from the burette, where it had displaced the water. After this volume had been reduced to standard atmospheric pressure the resulting volume was taken as a measure of the catalase content of the insect. Knowing the weight of the insect, the amount of catalase per 30 milligrammes of material was calculated. The calculation was made on the basis of 30 milligrammes of material, because it was found that three of the fireflies used weighed approximately 30 milligrammes. The hydrogen peroxide was prepared by diluting commercial hydrogen peroxide with an equal volume of distilled water. A full description of the method may be found in a previous publication.

Experiments.—Three fireflies previously ground up in a mortar with sand were introduced into a bottle containing 50 c.c. of hydrogen peroxide and the amount of oxygen liberated in 10 minutes was determined. Ten such determinations were made with an average of 118 c.c. of oxygen per 30 milligrammes of firefly. Similarly a moth ground up in sand was introduced into 50 c.c. of hydrogen peroxide and the amount of oxygen liberated determined. The average amount of oxygen liberated by moths was 8 c.c. of oxygen per 30 milligrammes of material. Determinations were also made using honey-bees, bumble-bees, and butterflies. The amount of oxygen liberated in none of these determinations exceeded 25 c.c. of oxygen per 30 milligrams of material. ,

Conclusions.—The catalase content of a luminous insect where oxidation is presumably more intense is greater than that of a non-luminous insect where oxidation is less intense.

W. E. Burge

University of Illinois

EFFECT OF SMELTER GASES ON INSECTS[1]

It is often claimed that the waste gases, particularly sulphur dioxide, thrown off during the process of smelting copper, lead and some other ores, have a very decided influence on the number of insects in the vicinity of the smelters. Some believe that few if any insects can live in such regions because of the baneful effect of the gases, others believe that insects are unusually abundant there, particularly in regions where more or less injury has been done to vegetation under conditions that formerly existed in some of the smelters. Bees are thought to be particularly susceptible to these gases and it is often claimed that their numbers are so reduced in smelter regions as to seriously affect the fruit crops because the flowers are not properly fertilized. There is no basis whatever for any such claims or beliefs. For several years I have spent all or part of each summer in studying the insects in regions where smelters are located and, for purposes of comparison, in similar adjacent regions, and in no instance have I been able to detect any differences in the number of insects or in the extent of insect injury, due to the presence of smelter gases.

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[1] From the Physiological Laboratory of the University of Illinois. From experiments carried out at Nela Research Laboratory.

[2] Dubois, "Mécanisme intime de la production de la lumière chez les organismes vivants," *Soc. Linneenne de Lyon, Imprimerie* A. Rey.

[3] Burge, *The American Journal of Physiology,* Vol. XLI., No. 2, August, 1916.

[1] Contribution from the laboratories of the American Smelting and Refining Co., department of agricultural investigations.

During the last three years the Department of Agricultural investigations of the American Smelting & Refining Co. has carried on extensive series of experiments to test the effect of sulphur dioxide on various kinds of vegetation. As insects are often covered over by the cabinets when they are placed over the plots of grain or other vegetation for fumigating, I have had many opportunities to watch their behavior when subjected to known quantities of sulphur dioxide.

The cabinets used in these experiments were about six feet square and five feet high and were made of celluloid with a light framework of wood. Through these cabinets a current of air carrying a known quantity of sulphur dioxide was driven by means of electric fans. Every precaution was taken to see that the concentration of the gas was constant in all parts of the cabinet throughout the experiment. The time of fumigation varied from half an hour to two or three hours. In every experiment a check cabinet where conditions were exactly similar, except for the absence of the sulphur dioxide, was used. The following sets of definite experiments and observations were made in 1916.

A number of honey bees were placed in a cabinet where SO_2 was being introduced, the strength being 1 part of SO_2 to 1 million parts of air. During the half hour that they were submitted to the fumigation the bees behaved in the same way as did other bees placed in the check cabinet where no gas was being introduced.

In another experiment bees, butterflies, grasshoppers and mosquitoes were placed in the cabinet where 5 parts of SO_2 to 1 million parts of air was being introduced. The experiment was continued for one hour during which time the insects behaved in a normal way, some of the grasshoppers feeding during much of the time as contentedly as they would have fed outside of the cabinet. When the cabinet was removed the insects flew or hopped away and none showed any ill effects due to the confinement for one hour in this concentration of the gas.

At another time while fumigating some alfalfa plants with a very high percentage of SO_2, 25 parts of the gas to 1 million parts of air, I watched a number of insects that were on the plants in the cabinet. The alfalfa weevils, adults and larvæ, went on with their work undisturbed. Flies, mosquitoes, leafhoppers, grasshoppers and ladybird beetles, behaved in a perfectly normal way and at the end of the hour over which the experiment extended, it could not be seen that the fumigation had had any effect on them.

As the concentration of gas in the last experiment was several times as high as we should ever find in the field even quite near the smelters, it is safe to say that the sulphur dioxide given off by the smelters has no effect whatever on the insects in that region.

It is true that SO_2 generated by burning sulphur in a room or other enclosed spaces is sometimes recommended for killing insects. But this is used at the rate of 2 lbs. of sulphur for every 1,000 cubic ft. of space. At sea level and at 20° C. or 68° F. this would give a concentration of gas equal to 24,009 parts of gas to one million parts of air. Even at this rate with prolonged fumigations the insects are not always all killed!

R. W. DOANE

STANFORD UNIVERSITY

SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y

THE STATIC ATOM[1]

I have been asked to present in this symposium the relation between atomic structure and the "valence bonds" by which the atoms are regarded as tied together, to form the more complicated structure of the molecule. Now the whole theory of molecular constitution which I have developed rests upon the fundamental postulate that the atom is internally at rest or nearly so. On the other hand, Bohr, who has given special attention to the phenomena of spectral series, has been led to the view that the electrons in the atom are revolving rapidly about a central positive nucleus. Because of the wide acceptance by physicists of Bohr's theory of the atom and its orbital electrons, and especially in view of the very lucid arguments in favor of this theory which Professor Millikan has just presented to us, I am going to ask your permission to modify the subject of my paper, and to discuss not the specific methods of combination among the atoms, but rather the question as to whether the electrons in the atom and the molecule are in rapid motion or are essentially at rest; for upon our answer to this question any theory of molecular structure must depend.

Now assuming that the electron plays some kind of essential rôle in the linking together of the atoms within the molecule, and, as far as I am aware, no one conversant with the main facts of chemistry would deny the validity of this assumption, let us consider the typical compounds of old-fashioned organic chemistry in regard to whose molecular structure we already know much—at the very least we may speak definitely of the relative positions of the atoms within their molecules. Among such compounds we find the striking phenomenon of isomerism. Numerous isomers, substances of precisely the same chemical constituents and differing only in the relative order in which the atoms are placed in the molecule, have been prepared. In the case of complex substances, if it were worth while, millions of such isomers could be prepared. Yet these isomers will keep for years, and probably would for centuries, without changing into one another. In these inert organic compounds the atoms are so persistently retained in definite positions in the molecule that in one part of the molecule atoms may be substituted for other atoms and groups for groups, sometimes through reactions of great violence, without disturbing the arrangement of the atoms in some other part of the molecule. It seems inconceivable that electrons which have any part in determining the structure of such a molecule could possess proper motion, whether orbital or chaotic, of any appreciable amplitude. We must assume rather that these electrons are held in the atom in fixed equilibrium positions, about which they may experience minute oscillations under the influence of high temperature or electric discharge, but from which they can not depart very far without altering the structure of any molecule in which the atom is held.

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[1] Presented at the symposium on "The Structure of Matter" at a joint meeting of the Sections of Physics and Chemistry of the American Association for the Advancement of Science, The American Physical Society and the American Chemical Society, New York, December 27, 1916.

Let us therefore consider whether the physicists on their part offer any irrefutable arguments in favor of an atomic model of the type of Bohr's. In an atom of the simplest type, composed of a single positive particle and a single electron, if these fail to merge with one another until their centers are coincident—and it is universally assumed that they do not so merge—only two explanations are possible: either the ordinary law of attraction between unlike charges (Coulomb's law) ceases to be valid at very small distances, or the electron must be in sufficiently rapid motion about the atom to offset the force of electric attraction. The first of these explanations is the one which I have adopted. The second, which has been adopted largely because it appears to save Coulomb's law, is the one which has led to Bohr's atomic model, in which the electron revolves in definite orbits about the central positive particle. Now it has frequently been pointed out, and indeed it was well recognized by Bohr himself, that this model is not consistent with the established principles of the electromagnetic theory, since in the classical theory a charged particle subjected to any kind of acceleration must radiate energy, while, according to the Bohr hypothesis, radiation occurs only when an electron falls from one stable orbit into another. Since, however, the equation for electromagnetic radiation is one of the more abstruse and less immediate deductions of the classical theory, it might be possible by slight modifications of the fundamental electromagnetic equations to reconcile them with the non-radiation of the orbital electron. I wish therefore to point out a far more fundamental objection to the theory of the revolving electron, due to the fact that Bohr has been forced to assume that this revolution must continue even down to the absolute zero of temperature.[3]

If, in Fig. 1, the circle represents the orbit of an electron *B* revolving about the positive center *A*, and if *C* represents a charged particle in the neighborhood, then if the electron exerts any influence what-

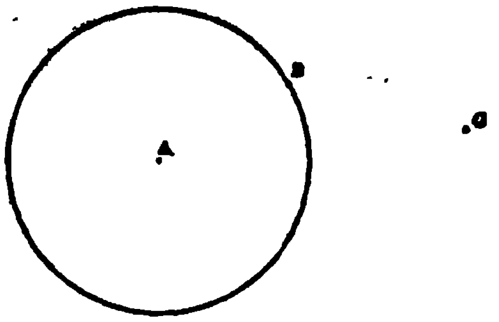

FIG. 1.

soever upon the particle *C*, the latter will be set into sympathetic motion, and a part of the energy of the *atom at the absolute zero* will be contributed to the particle *C*, contrary to the most fundamental principles of thermodynamics. Therefore, unless we are willing, under the onslaught of quantum theories, to throw overboard all of the basic principles of physical science, we must conclude that the electron in the Bohr atom not only ceases to obey Coulomb's law, but exerts no influence whatsoever upon another charged particle at any distance. Yet it is on the basis of Coulomb's law that the equations of Bohr were derived.

In spite of this and other similar serious objections to Bohr's atomic model, I should not wish to minimize the importance of his work. He has been the first to present any sort of acceptable picture of the mechanism by which spectral series are produced, and especially he has traced a relation between two important constants of nature, Rydberg's fundamental frequency, and the Planck constant *h* which plays so important a part in modern physical theory. I should therefore be loath to suggest an abandonment of the extremely interesting leads which Bohr's theory has suggested, nor do I think this necessary, for I believe that relationships similar to those obtained in Bohr's theory may be obtained, even if we substitute for the orbital atom of Bohr a static atom, and, moreover, I believe that by making this substitution we may not only obtain a model of the atom which is consistent with known chemical facts, but also one which does not require the abandonment of the principal laws of mechanics and electromagnetics. I should state at once, however, that I do not claim for the atomic model, which I am about to sketch in rough outline, the same finality that I would claim, for example, for the molecular model of methane which I have previously offered.[3] It is rather a suggestion of the direction in which we may work towards the solution of a problem of extraordinary difficulty with the most hope of ultimate success. It is evident to any one familiar with the extreme complexity of the spectra of some substances that many years must elapse before anything approaching to a final explanation of such baffling phenomena can be expected. All we can do at present is to suggest certain directions of investigation which may lead ultimately towards the desired end. With this understanding, you will not consider it too presumptuous if I start by discussing not the structure of the complicated system that we call the atom, but rather the structure of the electron itself, or, if you prefer, the structure of the field of force about the electron.

If we postulate, at small distances, the nonvalidity of Coulomb's law of force between the centers of two charged particles, we are doing nothing that is really new. In the older conception of the electron as a charged sphere of definite radius, the sphere being itself held together

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[2] It will be noted that this objection applies with equal force to the Planck oscillator which maintains energy even at the absolute zero.

[3] I refer here and elsewhere to my paper "The Atom and the Molecule," *J. Am. Chem. Soc.*, 38: 762, 1916. See also *Proc. Nat. Acad.*, 2: 586, 1916.

by forces of an admittedly mysterious character, Coulomb's law, in the ordinary sense, would fail when two electron centers approach within one electron diameter of each other. If, on the other hand, we abandon the rather artificial spherical model of the electron, and if we assume that the electron has all its charge concentrated at its center, then also it has been well recognized that Coulomb's law must fail, for otherwise we could not account for the finite mass of the electron. In this case also we might, if we chose, speak of the size of the electron, meaning thereby the distance from the center at which the electric force differs by a certain amount from that calculated by Coulomb's law. Now in either sense of the word we must agree with Rutherford that the positive nucleus of an atom is far smaller than the electron. In other words, two such positive nuclei will repel each other according to Coulomb's law even at distances so small that the law would have quite lost its validity for two electrons or for a positive particle and an electron. In other words, an atom composed of a single positive particle and an electron is to be regarded as though the positive particle were imbedded in the electron and not the electron in the positive nucleus, as in the older theory of J. J. Thomson.

Some years ago I was led, through consideration of electron theory alone, and by the aid of plausible assumptions, to an equation for the field of force about an electron, which, at that time, seemed to me a reasonable first approximation to the equation which we must substitute for Coulomb's law. If f is the force acting on an equal positive charge at the distance r from the point charge electron, if ϵ is the charge of the electron, e the base of natural logarithms, and r_0 a characteristic distance which does not differ much numerically from the radius which is ascribed to the spherical electron, the equation reads

$$f = \frac{\epsilon^2}{r^2} e^{r/r_0}.$$

At large values of r this obviously reduces to Coulomb's law; at small values it would correspond to a curve such as that given in Fig. 2, where f is the ordinate and r the abcissa.

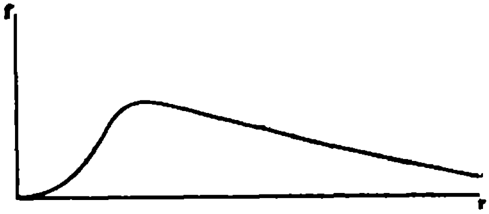

FIG. 2.

If now we assume that this is only a suggestion of the true equation and that the exponential term should be replaced by a similar function of periodic character, say a trigonometrical function of $1/r$, we might obtain an equation roughly represented by the curve given in Fig. 3. Any ordinary periodicity with respect to $1/r$ will make the curve which is plotted with respect to r intersect the axis of abscissæ an infinite number of times as r approaches zero. A positive particle (which we may regard as negligible in size but greatly preponderating in mass) situated at any of the intersections r_1, r_2, etc., where with diminishing r the force of attraction goes over into one of repulsion, is in a state of equilibrium with respect to the electron. Let us assume that

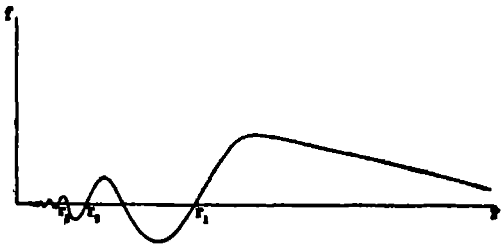

FIG. 3.

the slope of the curve at each intersection increases towards a finite limit as r approaches zero. This slope df/dr is the restoring force per unit displacement, and its square root determines the natural frequency of oscillation of the electron.[3] We thus have a picture of a system which, consistently with recognized principles of mechanics and electromagnetics, would give a series of spectral lines analogous to the series which are known for various elements. The limiting value of df/dr as r approaches zero determines the limiting frequency of the series. In the case of Balmer's hydrogen series this limiting frequency is equal to one fourth of the fundamental frequency which Rydberg has found associated with the series of a large number of elements. It has been argued that the existence of this fundamental frequency speaks for similarity of constitution of different atoms. Is it not simpler to assume that it is characteristic of the one thing which is common to all atoms emitting light, namely, the electron?

The condition which we have imposed regarding the slope of our curve at its intersections does not determine the area which will lie under any section of it. As the curve is drawn, the area under the r axis between r_1 and r_2, r_2 and r_3, etc., is greater than the area above the axis. In other words, the potential energy of the system increases as the positive particle is brought from r_1 to r_2, from r_2 to r_3, and so on. If now we fix the form of the curve so that $\int_{r_m}^{r_n} fdr$ is proportional to the difference between the values for r_n and r_m of $(df/dr)^{1/2}$, the potential energy of our system at any point of equilibrium is a linear function of the frequency which is characteristic of that position of equilibrium. We then have what is, to my mind, a very suggestive explanation of the Einstein photo-electric equation. If an electron moving with a given velocity meet a positive particle, the latter would penetrate the electron field to one of the positions of equilibrium, and the electron would oscillate with a frequency depending solely upon the equilibrium position it reaches and therefore upon its original kinetic energy. The higher the original velocity, the higher the frequency it is capable of exciting. On the other hand, if we assume the presence of atoms in which the electrons are in various positions of equilibrium with respect to the positive particle, and these atoms are subjected to light of a given frequency, the electron which possesses this as its natural frequency will oscillate with greater and greater amplitude until it is able to leave its position of unstable equilibrium and will then be ejected from the atom, acquiring a kinetic energy equal to the potential energy of its original position. On our assumptions the relation between frequency and velocity will be quantitatively that given by the Einstein equation.

In the time which has been allotted to me I can not further elaborate these points, but I hope that I have succeeded in making it seem plausible that some model of a static atom, perhaps only roughly resembling the one that I have outlined to you, may be expected to give at least as satisfactory an explanation of the phenomena of spectroscopy, and of the relationships between the natural constants which have been found in the study of radiation, as can be afforded by the orbital atom. If this is granted we may proceed with greater confidence to the further study of the group of atoms which we call the molecule, and to the nature of valence. I can not repeat here the reasons which I have given in another place for believing that it is these very electrons held in rigid positions in the outer shell of the atom which may, in case of chemical combination, become the joint property of two atoms, thus linking together the mutually repellant positive atomic kernels and themselves constituting the *bond* which has proved so serviceable in the interpretation of chemical phenomena. In some molecules, such as those of nitrogen, the linking electrons are held by powerful constraints. The molecule is inert and incapable of taking part readily in chemical reaction. In others, like those of iodine, in which the bond is said to be weak, the connecting electrons are held by loose constraints and the molecules are extremely reactive. But whether the bond be weak or strong, we may feel pretty sure that it solely consists of those electrons which are held as the joint property of two atomic shells and constrained to definite positions by forces which we do not at present understand, but which do not obey the simple law of inverse squares which characterizes the attraction or repulsion of charged bodies at relatively large distances from one another.

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[3] It will of course be understood that, owing to its much smaller mass, it is the electron that oscillates and not the positive particle. I am referring above to oscillations in the line of centers. In general the oscillations of an object which is held in space in a fixed position by constraints which differ in different directions will be resolved by either mathematical or physical analysis to give three frequencies corresponding to the three axes of constraint. If the constraint along two of these axes is the same the corresponding two frequencies will be identical. I venture to offer this as an explanation of the well-known fact that the lines of a series spectrum occur often as pairs or triplets.

Gilbert N. Lewis
University of California

ZOOLOGICAL RESEARCH[1]

I speak with mixed emotions. I long ago planned to attend this spring meeting of the Indiana Academy of Science, the first I have been able to attend in several years. I was asked to assist at the dedication of a new biological building, and find I am one of the orators on the rare occasion of the unveiling of a monument to a man still alive and present. It is not possible to speak in the presence of so lively a corpse of the appropriateness of having your newest and best building named in honor of Stanley Coulter. If he were not present and listening with such apparent anxiety, I should like to recall his many good qualities and my good fortune in being associated with him for a third of a century. In these years we have traveled together, played together, worked together, fought together and against each other, and I think I am beginning to know him in part. It would make him too vain were I to say all of the nice things I should feel more than justified in saying, if his family were in mourning. As it is, I can only commend the authorities in honoring the teacher, the director of the Indiana Biological Survey, the charter member of the Indiana Academy of Science, the leader in nature study, the investigator, the dean of the school of science of Purdue University, and over and above all, the real human being.

It will not detract from his merits if I tell you in confidence that he deserves but part of the credit for what he has done. The poet truly said: "There is a Divinity that shapes our ends." At least half the credit should go to his wife, who has made him possible, and whom those of us who know her love even more than we do Stanley. I hope, I am sure the Academy as well as Purdue University hope, that they will long be able to work in the building so well named. The best of it is that the building was not needed to perpetuate the memory and influence of our friends.

The dedication of this, your best building, in part to zoology is a just recognition of the importance of the subject. It is quite proper, therefore, that we should consider what we mean by zoology, for our interpretation determines the nature of the work to be done within the walls of Stanley Coulter Hall.

Zoology is a study of animals. The study of zoology as an intellectual pursuit gives liberal cultural training as well as a fuller appreciation of our fellow mortals. This fact in itself is a full justification of its study. But, in addition, zoology may be and is studied for the grounding preliminary training of certain of the professions, notably medicine and agriculture. The premedical man finds in zoology the basis for his future appreciation of the anatomy of man. Man carries many reminiscences of his lowlier ancestors. Even the over-devout believers of special creation seem to have had an inkling of this fact. On the walls of the sacred cemetery in Pisa a painter has represented the creation of man. On the left is the Lord, in the center is the man partly formed. To fill a gap in his canvas the painter placed a palm tree on the extreme right of the picture. A monkey is climbing the palm. Thus while the Lord is creating man "in His own image" a monkey is gamboling before his eyes—the result is only what might have been expected.

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[1] Remarks at the dedication of Stanley Coulter Hall, the new biological building at Purdue University, during a meeting of the Indiana Academy of Science.

Zoology has an additional importance to the doctor of medicine. Man, himself a zoological garden, is involuntarily harboring within, and frequently without, many of his zoologically more humble contemporaries. It must frequently be a question whether the malady is due to the anatomy and physiology of the patient himself, or to the depredation of the invaders.

Here at Purdue University it is quite proper that another phase of zoology should receive full recognition. The firing line in the most important struggle for existence on the globe is not along the Marne, but in man, in his flocks, his cultivated fields and forests. The supreme struggle is not between autocracy and democracy, but between man and insects and still lower creatures. Insects keep many large parts of the globe as free from man as No Man's Land, much freer than the submarine zone. Insects and still lower animals levy their enormous tribute at the source. Some day we may issue liberty bonds to open the lanes of travel in other parts of South America as we have opened those of Panama, and to free us from the tribute we are compelled to pay to the Hessian fly, the gypsy moth, the San José scale, the Mexican cotton-boll weevil, the English sparrow, the Colorado beetle, the German carp, and a host of other invading and native marauders.

A few years ago I had the pleasure of sailing to St. Thomas, St. Croix, St. Kitts, Santa Lucia and other West India Islands as holy as these, though not yet sainted. Some had elaborate barracks, but fortifications were being abandoned and attention lavished on botanic gardens and experiment stations. The change was a recognition of this ancient, but only recently fully recognized, firing line. We certainly have abundant excuse, if excuse is needed for this new biological building.

But there is another use for this building. It is no merit to call the doctor when the stomach aches. It *is* a supreme merit to investigate causes and prevent future stomach aches while we are enjoying our daily overabundant meals.

We must investigate zoology from its pure and abstract side, developing as a by-product of our investigations the future Pasteurs, Kochs and Darwins; we must extend human knowledge. All institutions must cooperate in this, must grow at the tip. Investigation is the truest preparedness, and the democracies ought at least to encourage research as much as the autocracies, known for their noble contributions in this direction.

In this connection I would like to quote (with slight modifications) from a letter to President Stanley Hall, of Clark University, written in answer to a questionnaire on the general subject of what can be done to increase research in American universities.

BLOOMINGTON, IND., Oct. 25, 1916

My dear Dr. Hall: It would be very easy to point out why the American universities do not do more for research, why you must ask the first of your questions. But, my dear President Hall, a candid statement would be sure to be resented by one or another university active in the councils of the Association of American Universities. To call attention to self-evident facts would seem like interference on the part of one institution with the internal policy of another. In criticism of the policy of American universities in regard to research, the head of one of the great research endowments remarked that his institution was appropriating more money to carry on research in one of the great universities than the university itself is devoting to this purpose. In visiting alumni associations the ambassador of another great institution bragged about the millions that were going into new buildings. At the same time there was internal complaint that research was being hampered by the lack of funds! Instances where research is eking out its hampered existence by the side of a great athletic plant or by the side of splendid costly halls, if not between the two, are not unique. As I am not permitted to stir up the animals—the very expression so unacademic—I will, in as academic and wooden a way as possible, discuss some of your questions, and point out in a mild way how the Nirvana of the research man may be approached, if not attained.

The first point in your circular letter raises the question of the function of the university, and of the university professor. Minot said that the function of the professor is "to carry on research and to teach others to do the same." If research is the function of the professor, *ipso facto*, it must be the function of the university. I think Minot's definition should include the central idea on which a prominent research institution was founded, if not conducted; to find the exceptional man and enable him to do the work for which he is best fitted. We will grant for the time, then, that it is the function of the university to find the exceptional man to carry on research, to enable him to make the most of his ability, and in his turn, to find exceptional men and enable them to do their utmost.

To this, the primary function of the university, as a close second comes the function of finding the other exceptional man, who can appreciate pure research and who is willing to let the university be the mediary between his own dollars and the university's research man.

If we grant all of the above, the answer to your first question becomes easy. If it is the function of the university to carry on research, there is evidently no reason why it should not engage men to carry on this function. Whether such men, or such a man, should devote part of his time, all of his time, or sporadically all of his time during leave of absence, are subsidiary questions, once it is granted that it is the function of the university to carry on research. University presidents, I fear, are usually too prone to believe in the efficacy of devotion, only so long as it is offered within hearing of the college bells. . . . The Carnegie Foundation has been criticised because it no longer pensions university professors with research proclivities at the end of twenty-five years of teaching. But, if it is the function of the university to carry on research, why should such men be pensioned? If the man is so wrapped up in research that he is willing to retire on decreased pay, that he may be able to devote himself exclusively to research, why not let him continue in one of the chief functions of the university on full, if not increased pay? The universities are trying to shirk when they criticize the Carnegie Foundation, because it refuses to help them carry on one branch of their work.

It goes without saying that the research man needs appropriations for apparatus or collections, or assistants or traveling expenses, and for publication. He can get some, if not all of these things, by cooperation with other institutions, the Carnegie Institution, the Elizabeth Thompson Science Fund, the Bache Fund, the American Association for the Advancement of Science, not to mention some others which help with money, or which cooperate in the matter of publication. The necessity for and existence of these research funds and institutions lies in the fact that the universities themselves failed to appreciate the necessity for research, failed to make adequate provision for it. The research funds stand in the same relation to the universities and to the public, that the interurban railways stand to the steam railways and the public. Frequently the time of the research man consumed in diplomacy, in getting the cooperation of people and institutions inclined for the most part to pull in different directions, could have been spent to better advantage in other ways. Digging the bait is more laborious, and always more tiresome, than fishing.

If it is the function of the university to carry on research and to teach others to do so, then of course, the university should discriminate between those gifted in teaching and those gifted in investigation. Your very question, "Must the many other research institutions outside the universities be mainly relied upon for this work?" is sin against the Holy Ghost.

The centers of some lines of pure research, cytology and genetics for example, had shifted to America before the great war. With the untempered democracy of high explosive shells of both contestants, which kill the most highly trained specialist by the side of the day laborer, it will naturally become the duty as well as the privilege of America, to still further enter into friendly rivalry with Europe—for it is to be hoped that in the field of scientific research, there will be no trace of any but friendly attitude toward any of the European countries.[3] America will ultimately lead in idealistic endeavors. It would have done so, war or no war. The thing that will help more than any other to give leadership, is to have the universities make a special effort to gather the funds needed, to enable the men specially gifted in research to do their utmost.

Having secured the building, Mr. President, I hope you will provide the money to enable the men who are to be housed in it to do their best.

C. H. EIGENMANN

SCIENTIFIC EVENTS

RECONSTRUCTION HOSPITALS AND ORTHOPEDIC SURGERY

THE Surgeon General of the Army, Major General William C. Gorgas, authorizes the publication of the statement that the whole conception of governmental and national responsibility for caring for the wounded has undergone radical change during the months of study given the subject by experts serving with the Medical Officers' Reserve Corps and others consulting with them. Instead of the old idea that responsibility ended with the return of the soldier to private life with his wounds healed and such pension as he might be given, it is now considered that it is the duty of the government to equip and reeducate the wounded man, after healing his wounds, and to return him to civil life ready to be as useful to himself and his country as possible.

To carry out this idea plans are well under way for building "reconstruction hospitals" in large centers of population. Sites have been chosen, though not all finally approved, in the following cities: Boston, New York, Philadelphia, Baltimore, Washington, Buffalo, Cincinnati, Chicago, St. Paul, Seattle, San Francisco, Los Angeles, Denver, Kansas City, St. Louis, Memphis, Richmond, Atlanta, and New Orleans. Those in Boston, New York, Washington, and Chicago will probably be constructed first. Each will be built as a 500-bed hospital, but with provision for enlargement to 1,000 beds if needed.

These hospitals will not be the last step in the return of the wounded soldiers to civil life. When the soldiers are able to take up industrial training, further provision will be ready. The injured man may be retrained to his previous occupation to conform with his handicapped condition or retrained for a new industry compatible with that condition. Additional education will be given to those fitted for it, and men may in some cases be returned to more valuable work than that from which they were called to war. Workshops will be provided at the hospitals, but arrangements will also be made with outside industries whereby more elaborate methods of training may be carried on. An employment bureau will be established to place men so trained in different parts of the United States.

This whole matter comes under the department of military orthopedic surgery recently organized in the Medical Department of the Army. The following officers of the Medical Reserve Corps are in charge of the work: Major Elliott G. Brackett, of Boston, director of the department of military orthopedics to the Surgeon General; Major Joel E. Goldthwait, of Boston, director of military orthopedics for the expeditionary forces; Major David Silver, of Pittsburgh, assistant director of military orthopedics to the Surgeon General. The following, in conjunction with the above staff, compose the orthopedic council; Dr. Fred H. Albee, of New York; Dr. G. Gwilym Davis, of Philadelphia; Dr. Albert H. Freiberg, of Cincinnati; Dr. Robert W. Lovett, of Boston; and Dr. John L. Porter, of Chicago.

Arrangements have been made by the department of military orthopedics to care for soldiers, so far as orthopedics (the prevention of deformity) is concerned, continuously until they are returned either to active service or civil life. Orthopedic surgeons will be attached to the medical force near the firing line and to the different hospitals back to the base orthopedic hospital, which will be established within 100 miles of the firing line. In this hospital, in addition to orthopedic surgical care, there will be equipment for surgical reconstruction work and "curative workshops" in which men will acquire ability to use injured members while doing work interesting and useful in itself. This method has supplanted the old and tiresome one of prescribing a set of motions for a man to go through with no other purpose than to reacquire use of his injured part.

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[3] This letter was written before the United States entered the war.

In addition to the American orthopedic surgeons now working abroad under Col. Jones, of England, others will soon go overseas. Experienced surgeons, and a large number of younger surgeons who will work under competent directors, will go abroad for this work, all to be under the direction of Major Goldthwait. These orthopedic surgeons will work in England among the British force and when needed will be transferred to France to work among American soldiers.

It is not the intention that men able to go back to the firing line shall be returned to this country unless their convalescence will extend over a period of a considerable number of months. Soldiers unable to return to duty will be sent to the reconstruction hospitals in the United States.

Instructors and examiners for all the camps are also being furnished by the department of military orthopedic surgery. A number of older and more experienced surgeons will act as instructors and supervisors for each of the groups into which the camps will be divided; a number of orthopedic surgeons will be detailed as attending surgeons at each camp to act as examiners and as consultants to the camp's other surgeons.

FOREST BATTALIONS FOR SERVICE IN FRANCE

The formation of a second "Forest" regiment comprising ten battalions and composed of lumbermen and woodworkers, who will go to France and get out of the forests materials for the use of the American, French and British armies, has been authorized by the War Department.

Two battalions are to be raised at once with the active aid of the Forest Service of the Department of Agriculture. It is expected that the remaining eight battalions will be called for in a short time. Nine "service" battalions, made up of laborers who will be used in connection with the Forest regiment, have also been authorized and two battalions have been ordered raised at once.

In order to provide for future contingencies it has been decided to commission at the present time enough officers for other battalions yet to be raised. Those men not needed now will be placed on the reserve, and will be called as the other units are formed. According to the present plan, fifty per cent. of the officers will be sawmill and logging operators, twenty-five per cent. will be technical foresters, and twenty-five per cent. will be men with military tenants will be selected in the immediate future. The minimum age limit for commissioned officers has been set at thirty-one.

A considerable number of captains and lieutenants to be selected in the immediate future. The minimum age limit for commissioned officers has been set at thirty-one.

A first regiment of woodsmen numbering about 1,200 men and designated as the Tenth Engineers (Forest) has already been recruited and assembled and is now being trained at American University, D. C. This regiment was raised at the request of the British government to undertake the production in France of crossties, bridge, trench and construction timbers, mine props, lumber, and other forms of wood required in connection with its military operations. The landing of the American expeditionary forces has made necessary similar provision for their needs, while the French military authorities have indicated that some of the work incidental to their operations might be taken over by woodsmen from this country. Decision to raise the new and much larger force has followed a study of the field of possible usefulness to the Allied cause, made by American foresters attached to General Pershing's staff.

Each of the ten battalions of the second regiment will comprise three companies of 250 men each, and will be under the command of its own major. The regiment will be made up of volunteers. Applicants must be white and between the ages of eighteen and forty.

Skilled lumberjacks, portable mill operators, tie cutters, logging teamsters, camp cooks, millwrights and charcoal burners are among the classes of men desired. For the "service" battalions both negro and white laborers will be enlisted.

OCCUPATIONAL CENSUS OF THE ARMY

THE War Department has authorized the following statement:

There is now being made under the direction of the Adjutant General a comprehensive occupational and educational census of the men of the National Army.

The object is to carry the selective service law to its logical conclusion and to increase the efficiency of the army by putting the right man in the right place.

With this in view, a personnel organization has been established in each of the 16 cantonments. The previous occupation, education and preference for service of every man are recorded on individual cards, which are then filed and analyzed at the divisional personnel office in each cantonment. An analysis as to the entire 687,000 men of the first increment can readily be made from these records.

In this work the War Department is having the assistance of a body of civilian experts organized under the name "Committee on classification of personnel in the Army" and including a number of professional employment managers loaned to the government by large industrial and business concerns. The data collected will be used within the divisional organizations to assist division commanders in making the best possible assignment of their men. It will also be of importance in locating men fitted for special branches of the service, such as Aviation, the Ordnance Corps, etc., for which it may be necessary to assign men from the cantonments.

It must not be assumed that men can continue their old occupations in the army. The function of an army is to fight and most of the men irrespective of previous occupations, will be in the infantry and artillery. Nevertheless, the specialization of modern war requires large numbers of skilled men adapted for technical units and special branches of the service. The locating and placing of such men to the best advantage is of vital importance.

OPPORTUNITY FOR PHYSIOLOGISTS AND BIOCHEMISTS

THE Surgeon General of the army is organizing a Food Division of his office, the object of which is to safeguard the nutritional interests of the army by means of competent inspection of food from the standpoint of nutritive value, the supervision of mess conditions, including the economical utilization of food, and a study of the suitability of the army ration for troops in the camp and in the field. Well-trained physiologists and biochemists are needed to direct this work. These men are being commissioned, according to age and experience, as first lieutenants and captains in the Sanitary Corps, Medical Department; or, if they have medical degrees, in the Medical Reserve Corps.

It is probable there will be as many commissioned officers as there are camps and cantonments. Nutritional surveys will be conducted at the camps by surveying parties composed of these commissioned officers, and of drafted men, who have had scientific training, acting as assistants and clerks. It is estimated that such a survey can be completed in from ten days to two weeks for each camp.

It is hoped by means of these surveying parties also to instruct the company mess sergeants and company cooks in improved methods of selecting and preparing the foods. A school for the finished training of the scientists employed in this work is now being organized. The organization of the army, the army methods of handling and cooking foods, the latest methods of food examination and analysis, the conduct of the food survey and kindred topics will be covered by competent instructors from various departments of the army and other departments of the national government.

The facilities of the Bureau of Chemistry, including its analytical laboratories scattered over the country, have been placed at the disposal of the Food Division for this work. Analyses of the garbage will be made and of all foods whose composition is not already known, and the actual distribution of nutrients and of total calories consumed by the men will be computed. Any alteration of the army ration in the future will be based only upon the facts as thus gathered. There is every promise that this service will prove to be of strategic importance in the control of the health and welfare of the troops from the place of their mobilization to the battle front.

PSYCHOLOGICAL EXAMINATION OF RECRUITS

Appointments for psychological examiners in the National Army Cantonments, Camp Lee, Petersburg, Va.; Camp Dix, Wrightstown, N. J.; Camp Devens, Ayer, Mass.; Camp Taylor, Louisville, Ky., have been made as follows:

Major, Robert M. Yerkes, Surgeon General's Office, in charge of psychological work. Lieutenant Arthur S. Otis in charge of statistical work in the Surgeon General's Office, Section of Psychology.

Lieutenants Clarence S. Yoakum, Marion R. Trabue, Jos. W. Hayes, and Wm. S. Foster to serve as chief psychological examiners.

Lieutenants Geo. O. Ferguson, Jr., Walter S. Hunter, Edw. S. Jones, Karl T. Waugh, Heber B. Cummings, Edgar A. Doll, John T. Metcalf, Herschel T. Manuel, Carl C. Brigham, John E. Anderson, Horace B. English and Harold A. Richmond to serve as psychological examiners.

In addition to the above commissioned examiners, the following have been given civil appointment for psychological examining: Doctors Leo J. Brueckner, Donald G. Paterson, A. S. Edwards, Rudolph Pintner, Benj. F. Pittenger, Ben. D. Wood, John W. Bridges, J. Crosby Chapman, John K. Norton, Edward C. Rowe, J. David Houser, C. P. Stone, Thos. H. Haines, Norbert J. Melville, H. P. Shumway, Chas. H. Toll, Thos. M. Stokes, C. C. Stech, John J. B. Morgan, Raymond H. Wheeler, Harold C. Bingham, Carl R. Brown, Chester E. Kellogg, Ralph S. Roberts, and D. L. Hoppinginer.

SECTION OF ZOOLOGY OF THE AMERICAN ASSOCIATION

The annual meeting of Section F (Zoology) of the American Association for the Advancement of Science will be held at Pittsburgh, Pa., during Convocation Week on Saturday, Monday and Tuesday, December 29, 31 and January 1, under the presidency of Professor Herbert Osborn, of the Ohio State University. The opening sessions on Saturday will be devoted to the reading of technical papers, the titles of which together with brief abstracts of not over three hundred words must be in the hands of the secretary not later than December 10 in order to appear on the printed program. A joint smoker with the American Society of Naturalists is planned for Saturday evening.

The address of the retiring vice-president will be read by Professor George Howard Parker, of Harvard University, at the morning session on Monday, December 31. The "General Interest Session" will be held on Monday afternoon and will consist of a symposium on "The Contribution of Zoology to Human Welfare." Papers on this important subject will be read by Doctor Hugh M. Smith, U. S. Commissioner of Fisheries; Dr. L. O. Howard, chief entomologist of the U. S. Department of Agriculture; Dr. Charles Wardell Stiles, U. S. Public Health Service; and Professor Maurice A. Bigelow, director of the School of Practical Arts of Columbia University. The sessions of Tuesday, January 1, will be held in conjunction with the American Society of Naturalists and will close with the Naturalists' dinner on Tuesday evening.

SCIENTIFIC NOTES AND NEWS

The Surgeon General of the army, Major General William C. Gorgas, has established a board to collect material for the medical and surgical history of American participation in the European War. This board is composed of Colonel C. C. McCulloch, librarian of the Army Medical Library; Major F. H. Garrison, assistant librarian in direct charge of work on the history, and Captain John S. Fulton, secretary of the Maryland State Board of Health, who will have charge of the statistical work.

Dr. Veranus A. Moore, dean of the veterinary college of Cornell University, has been in Washington, serving as an adviser of Surgeon General Gorgas in the organization of the

Veterinary Officers' Reserve Corps. Dr. Moore is a member of the committee on military service of the American Veterinary Medical Association. That committee had been serving as a board advisory to the Surgeon General and Dr. Moore was elected to represent it in the Surgeon General's office.

DR. A. R. DAVIS, assistant professor of agricultural botany, the University of Nebraska, has been commissioned captain in the Coast Artillery, U. S. R. He is at present assistant ordnance officer, Fort Howard, Maryland.

CARL H. BUTMAN, who has been editorial assistant at the Smithsonian Institution for the last seven years, has resigned to become Washington editor of a new aviation magazine, *Air Service Journal.*

PROFESSOR ARTHUR D. BUTTERFIELD, head of the department of mathematics of the Worcester Polytechnic Institute, has resigned, as he expects to be called for service as captain in the aviation branch of the signal corps. Professor David L. Gallup, head of the gas engineering department, will also resign on October 1, having accepted a position as head of the research laboratories of the Nordyke & Marmon Company.

PROFESSOR A. M. BUCK, who for the last six years has been in charge of electric railway courses at the University of Illinois, has resigned to join Mr. John A. Beeler, of New York, in the consulting field. His new work will consist largely of investigations dealing with the construction, operation and management of electric railway properties.

DR. MAX KAHN has resigned his position as biochemist to the Western Pennsylvania Hospital, Pittsburgh, Pa., to accept the appointment of director of the laboratories, Beth Israel Hospital, New York City.

GEORGE H. STICKNEY, of Montclair, N. J., has been elected president of the Illuminating Engineering Society.

THE recently established Engineering Council has appointed the following standing committees: On Public Affairs—C. W. Baker, G. F. Swain, S. J. Jennings and E. W. Rice, Jr. On Rules—J. P. Channing, Clemens Herschel, N. A. Carle and D. S. Jacobus. On Finance—B. B. Thayer, I. E. Moultrop, Calvert Townley and Alexander C. Humphreys. The council has also created a war inventions committee, comprising H. W. Buck, A. M. Greene, Jr. and E. B. Kirkby, to cooperate with the Naval Advisory Board and other departments at Washington. It also created a committee, comprising George J. Foran, E. B. Sturgis, A. S. McAllister and A. D. Flinn, which is to collect and compile such information regarding engineers of the country as will enable it to cooperate with the different departments of the federal government.

IT is stated in *Nature* that a committee to inquire into various matters connected with the *personnel* and administration of the army medical services has been appointed by the British Secretary of State for War. The committee is composed of Major-General Sir F. Howard (chairman), Sir Rickman J. Godlee, Bart., Sir Frederick Taylor, Bart., Sir W. Watson-Cheyne, Bart., Dr. Norman Walker, Lieutenant-Colonel A. J. Stiles, Dr. Buttar and Dr. J. B. Christopherson (secretary). It will begin its work in France, and afterwards carry out similar investigations in England.

Two new orders have been instituted by the British king in recognition of services rendered by British subjects and their Allies in connection with the war, viz., the Order of the British Empire and the Order of the Companions of Honor. The Order of the British Empire has five classes, viz.: *Men:* (1) Knights Grand Cross (G.B.E.); (2) Knights Commanders (K.B.E.); (3) Commanders (C.B.E.); (4) Officers (O.B.E.); (5) Members (M.B.E.). *Women:* (1) Dames Grand Cross (G.B.E.); (2) Dames Commanders (D.B.E.); (3) Commanders (C.B.E.); (4) Officers (O.B.E.); (5) Members (M.B.E.). The first two classes, in the case of men, carry the honor of knighthood, and in the case of women the privilege of prefixing the title "Dame" to their names. The first lists of appointments to the orders have been issued. *Nature* selects the following as those known for contributions to science: To the Order of the British Empire: Lord Moulton and Lord Sydenham (G.B.E.); Mr. Dugald

Clerk, Professor H. S. Jackson and Mr. R. Threlfall (K.B.E.); Dr. Garrett Anderson, Professor H. B. Baker, Mr. L. Bairstow, Professor W. H. Bragg, Professor S. J. Chapman, Mr. W. Duddell, Mr. F. W. Harbord, Professor F. W. Keeble, Dr. Mary A. D. Scharlieb and Professor J. F. Thorpe (C.B.E.); Professor J. C. McLennan (O.B.E.). The following have, among others, been appointed Companions of Honor: The Hon. E. Strutt and Professor Ripper.

According to the London *Times* the program for the autumn meeting of the Iron and Steel Institute, held at the Institution of Civil Engineers on September 20 and 21, included the following papers: "Present practise in briquetting of iron ores," by G. Barrett and T. B. Rogerson; "Microstructure of commercially pure iron between Ar$_3$ and Ar$_2$," by W. J. Brooke and F. F. Hunting; "The influence of heat treatment on the electrical and thermal resistivity and thermo-electric potential of some steels," by E. D. Campbell and W. C. Dowd; "New impact testing experiments," by G. Charpy and A. Cornu-Thénard; "Heat treatment of gray cast iron," by J. E. Hurst; "Effect of mass on heat treatment," by E. F. Law; "Investigation upon a cast of acid open-hearth steel," by T. D. Morgans and F. Rogers; "The acid open-hearth process," by F. Rogers; "The Eggertz test for combined carbon in steel," by J. H. Whiteley, and "Failure of boiler plates in service, and investigation of stresses occurring in riveted joints," by E. B. Wolff.

The autumn meeting of the Institute of Metals was held in the rooms of the Chemical Society, London, in Burlington House, on September 19. The papers presented were: "Experiments on the fatigue of brasses," by Dr. B. Parker Haigh; "Hardness and hardening," by Professor T. Turner; "The effects of heat at various temperatures on the rate of softening of cold-rolled aluminium sheet," by Professor H. C. H. Carpenter and L. Taverner; "A comparison screen for brass," by O. W. Ellis; "Further notes on a high temperature thermostat," by J. L. Haughton and D. Hanson; "Principles and methods of a new system of gas-firing," by A. C. Ionides; "Fuel economy in brass-melting furnaces," by L. C. Harvey, with additional notes by H. J. Yates; "The effect of great hydrostatic pressure on the physical properties of metals," by Professor Zay Jeffries, and the "Use of chromic acid and hydrogen peroxide as an etching agent," by S. W. Miller.

We learn from *Nature* that donations and promises towards the Ramsay Memorial Fund received by the treasurers amount so far to £21,352, including £835 from members of the British Science Guild; £500 from Sir George Beilby, and £100 each from Lord Rosebery, the Company of Clothworkers, and the Salt Union, Ltd. Professor Orme Masson, of the University of Melbourne, has undertaken to act as the representative and corresponding member of the committee for Australia. As already announced, Professor C. Baskerville, of the College of the City of New York, is acting in a similar capacity for the United States.

Charles Lee Crandall, emeritus professor of railway engineering and geodesy in Cornell University, died at his home in Ithaca on August 25, aged sixty-seven years.

Dr. Lewis Atterbury Stimson, professor of surgery in Cornell Medical College, died on September 17, in his seventy-fifth year.

Mr. Walter E. Archer, known for his work on English sea fisheries, died on August 19 at Sand, Norway, at the age of sixty-two years.

Major A. N. Leeds, the English paleontologist, died on August 25 at the age of seventy years.

The first of the four volumes of the Decennial index to *Chemical Abstracts* was issued September 20. This first volume, which contains a little over 1,000 pages, is devoted to authors, A to K. The completed index will be virtually a complete record of the world's accomplishments in chemistry during the period 1907 *to* 1916.

The War Industries Board has requested the subcommittee on fertilisers to make an immediate survey of the nitrate of soda consumption and requirements in the fertiliser industry. Blanks are being mailed to the entire fertilizer industry. It is requested that this information be placed in the hands of the War Industries Board at the earliest possible moment.

By decree of September 12, the president of Cuba has modified the Commission of Plant Sanitation to an Office of Plant Sanitation with Mr. John R. Johnston, former president of the commission, remaining as chief of the office. The duties of this new office are the same as of the former commission, it being the sole office to issue certificates for the exportation of plants, in charge of all plant-quarantine problems, and entrusted with the eradication of the "black fly," *Aleurocanthus woglumi*, the control of the coconut budrot, the banana blight and other insect pests and plant diseases.

The report of the Education Branch of the British Board of Agriculture and Fisheries for the year 1915–16 is summarized in *Nature*. The report is said to afford evidence that, despite the severe restrictions imposed by the war upon the development of agricultural education and research, much useful work was accomplished during the year under review. There was a great decrease in the numbers of students taking long courses of instruction, whereas the numbers taking short courses were more than maintained. The Royal Agricultural College, Cirencester, and the Agricultural College, Uckfield, Sussex, were closed and the grants were withdrawn from two other institutions as a measure of war economy. Research work suffered severely owing to the heavy drain upon the staffs for army or munition purposes, but much useful work on problems of immediate technical importance was accomplished, of which the investigations at Cambridge on wheat-breeding and at Rothamsted on soil and manurial problems may be singled out for special mention.

UNIVERSITY AND EDUCATIONAL NEWS

Governor James E. Ferguson, of Texas, has been impeached by the legislature. The charges against him were financial irregularities and improper interference with the board of regents of the state university. The bill providing for the financial support of the university for the next biennium, which was vetoed by Governor Ferguson, has been re-passed by the legislature and signed by the acting governor. The professors who were dismissed at the instigation of Governor Ferguson have been reinstated.

Yale University has received since commencement gifts amounting to $362,393.05. The largest was $100,000 from Mrs. Edward H. Harriman for the Harriman Fund for Obstetrics in the Medical School. Another gift was that of $50,000 from Charles F. Brooker, of Ansonia, also for the Medical School.

It is now announced that the offer of the opening of the Harvard Medical School will be withdrawn, only one woman having replied, who was regarded as a desirable student.

Professor Walter E. Clark, head of the department of political science in the New York City College, has been elected president of the University of Nevada

George F. Kay, B.A., M.A. (Toronto), Ph.D. (Chicago), has been elected dean of the college of liberal arts of the University of Iowa. Dr. Kay will continue to be head of the department of geology in the university, and state geologist of Iowa.

Mr. Simon Marcovitch, assistant entomologist for the past three years at the University of Minnesota, has resigned his position to accept the position of head of the department of biology at the National Farm School, Bucks county, Pennsylvania.

Eugene Deatrick, Ph.D. (Cornell), has been appointed professor of soils at the Pennsylvania State School of Forestry, Mont Alto, Pa.

Mr. Harry B. Yocom, who recently received his Ph.D. from the University of California, has been appointed to the professorship of zoology in Washburn College, Topeka, Kansas, to succeed the late Johnathan Risser.

DISCUSSION AND CORRESPONDENCE

THE COLORS OF LETTERS

Some twenty-five years ago or more I published in *The Popular Science Monthly*, a little paper on "The Color of Letters." In it I referred to a curious form of association of

	Eric Jordan, 1912	Eric Jordan, 1917	David Starr Jordan	Majorie Edwards	Edith Snow
A	red	red bright	brown red	colorless	golden
B	bluish	gray	green	brown	dark blue
C	white	white	yellowish white	pink	pale yellow
D	bluish	gray	blue	purple	dark green
E	pale green	yellow	red	colorless	blue silver
F	red brown	brown	pale scarlet	scarlet	silver
G	pale brown	yellow	pale yellow	dark blue	pale brown
H	green	yellow	brown red	heliotrope	pale green
I	black	black	leaden black	red	silver
J	dark blue	greenish	leaden	dull green	red
K	brown	brown	lead violet	pink	plum color
L	pale green	green	green	yellow	dark green
M	red	brown	lead blue	dull rose	dark brown
N	pale greenish	light brown	brown red	pale green	brick red
O	light blue	black	white	orange	white
P	yellow	yellow	lead color	lavender	lemon yellow
Q	pale red	red brown	bluish white	yellow	drab
R	dark green	dark red	bright green	red	black
S	silvery gold	silver	bright yellow	green	pale red
T	white	silver	green	yellow	pale bluish green
U	yellow	yellow brown	yellowish	colorless	drab
V	silver	white	violet blue	black	blue green
W	red brown	brown	lead blue	white	blue black
X	silver	silver	scarlet	blue	red
Y	silver	white	blue	colorless	aark yellow
Z	reddish	dark brown	scarlet	green	dark red

color with the letters of the alphabet. This faculty has been called "Pseudo-chromæsthesia," which, I take it, means sensitiveness to false colors. It has been misunderstood by writers, who have imagined that the peculiar individuals having this trait actually see the color on the letter, which is not the fact. It is a mental association, not a false vision. Some have attributed it to a recollection of color blocks from which letters have been learned. To the "pseudochromæsthetic" this explanation is nonsense. It is, however, a fact that the tendency of this association of letters with colors is hereditary, and that it goes with a certain interest in word-using and in the use of color, features capable in each case of development.

When my son Eric was eight years old, no one ever having spoken of it to him before, I asked him what is the color of A? He responded at once that it is red. At that time, 1912, I made out a list of the alphabet with the colors assigned to each. Quite recently (1917) I repeated the question, never having mentioned the matter since. He said at once that A was red and seemed slightly surprised that any one should not see the difference in innate color between red A and yellow E.

A few changes appeared, however, in his chromatic scale. These seem, however, to indicate vagueness of color, as the same impression might be described as bluish in one case and greenish or gray in another. For the sake of those this note may interest, I append my own chromatic scale which has not changed appreciably since I first thought of it, with those of two former students, the one my own niece, Marjorie Edwards (now Mrs. Frank Blake), and Edith Snow, daughter of the late Dr. Frank Snow, former president of the University of Kansas.

David Starr Jordan

A SIMPLE DEMONSTRATION FOR EULER'S DYNAMICAL EQUATIONS

Teachers of analytic mechanics may perhaps be interested in a demonstration which I have used for the past two years and which seems to illuminate Euler's equations for the rotation of a rigid body. The experiment is so simple that it has doubtless been used before, but I do not recall ever seeing it described.

GH is an ordinary support rod some 70 cm. long. *IJ* is a suspending cord. The ring *I* is set at such a point that when the rod is at rest

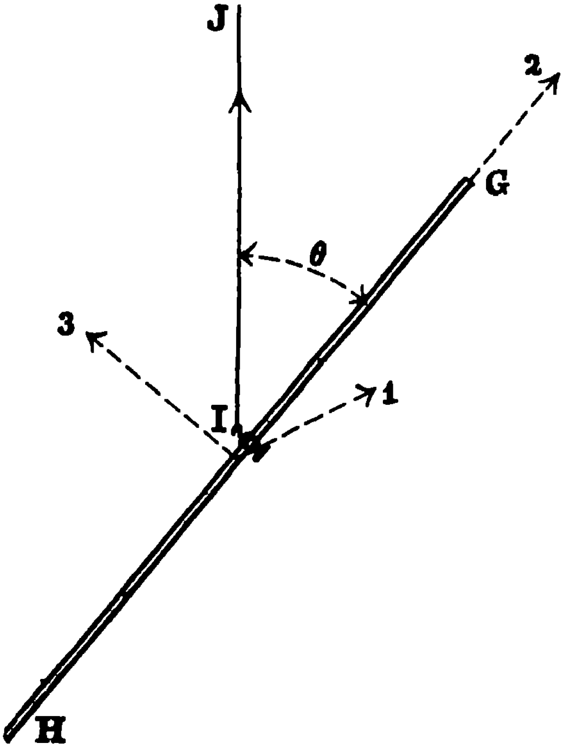

FIG. 1.

the angle *GIJ* is somewhat less than 45°. The center of gravity of the system then lies vertically below the cord. Choose axes fixed in the body as follows: For the axis *1* take a horizontal line through the center of gravity and perpendicular to the plane *GIJ*, for axis *2* take the axis of the rod, and for axis *3* take a line through the center of gravity and perpendicular to the plane of *1* and *2*, *3* will then lie in the plane *GIJ*. These axes are represented in the figure, where the axis *1* is supposed to project directly towards us, and the coordinate system is consequently right handed. Take right-handed rotation as positive. Then Euler's first equation may be written

$$A\frac{d\omega_1}{dt} - (B - C)\omega_2\omega_3 = L, \qquad (1)$$

where *A*, *B*, and *C* stand, respectively, for the moments of inertia about the axes *1*, *2*, *3*; ω_1, ω_2, ω_3 for the angular velocities about those same axes; and *L* for any external torque which may be acting about axis *1*. In the present case we have very nearly $B = 0$ and $C = A$, so that equation (1) becomes

$$\frac{d\omega_1}{dt} + \omega_2\omega_3 = \frac{L}{A}. \qquad (2)$$

Now give to the system a right-handed rotation about *IJ*. We then have $\omega_2 > 0$ and $\omega_3 > 0$. If the center of gravity were to stay immediately below the cord we should have $L = 0$ and therefore $d\omega_1/dt < 0$. But this would increase the angle θ and so throw the center of gravity out from underneath *IJ*. The weight of the system and the tension in *IJ* would then supply a positive torque *L*. It is possible to have this torque of such magnitude as to make $d\omega_1/dt = 0$, in which case the torque is entirely non-momental. The reason for the necessity of this non-momontal torque is easily seen by considering an element of the rod near *G* or *H*. When the rod is rotating there must act upon this element a centripetal force directed toward the axis *IJ*. This force is supplied by means of the torque *L*.

A rotation of sufficient magnitude to make θ very evidently greater than it is when the system is at rest is easily imparted by hand.

ARTHUR TABER JONES
SMITH COLLEGE

A UNIQUE HORNET'S NEST

IN the magazine, *The Guide to Nature*, Vol. 10, No. 1, June, 1917, Earl A. Newhall, of Shelburne, Mass., under the title "The nest of an unknown hornet," mentions a hornet's nest of peculiar form which he found hanging under the eaves of an old shop. An excellent photograph of this strange nest accompanies the article. Newhall wrote to Dr. L. O. Howard, of the Bureau of Entomology, sending a photograph of the nest. Dr. Howard states:

> I never saw a hornet's nest like the one in the photograph and I have referred your letter to Mr. S. A. Rohwer, of this bureau, who has studied these creatures for many years and he replies as follows: "I have never seen a nest like this before and do not know if it is an abnormal one or not. If possible, I should like to have some of the ma-

kers so that it would be possible to determine the species and thus know if it is abnormal habit.

The nest in question consisted of a globular portion which was abruptly contracted below into a long, slender, vertical neck of practically uniform diameter. This slender neck served as the only means of entrance into the structure.

The writer wishes to state that he once found one of these unique nests at Oxford, Mass., many years ago. This nest was kept as a curiosity in the writer's collections for many years and did not fail to excite the wonder and admiration of those who saw it. In size and shape this nest was similar to the one found by Newhall at Shelburne, Mass. Newhall states that he found his specimen under the eaves of a building. As well as the writer can remember, the nest which he found at Oxford, Mass., was suspended from a small branch of a tree not far from the ground. The maker of the nest was never seen. Although the writer has always kept a sharp eye open since for other specimens of this kind, none has ever been seen. It would be of considerable interest to know whether the two unique nests in question really represent abnormal deviations of habit for some well-known species, or the normal habit of nest-construction for a very rare and little known, or even unknown, species.

H. A. Allard

Washington, D. C.

SYNCHRONISM IN THE FLASHING OF FIREFLIES

The articles on the flashing of fireflies which have appeared from time to time in Science have aroused my desire to experiment upon the subject. The presence of two individuals of the firefly, *Photuris pennsylvanica* DeG., in my tent at the University of Michigan Biological Station at Douglas Lake, Mich., on the evening of July 17, 1917, gave me my first opportunity. With the tent dark, I watched the two fireflies for about ten minutes. For a while they flashed alternately, but it soon became apparent that one was flashing a trifle more frequently than the other. Consequently, once in every two and one half to three minutes flashing was simultaneous. Then for about twenty minutes I experimented with a three-celled vest pocket flashlight with the following results. I could easily get in rhythm with the firefly, but I could not make the firefly change its rhythm and keep with me. Sometimes the fireflies would stop while I was flashing the light and again they would continue to flash after I stopped flashing. At no time could I control their flashings. The flashlight and the two fireflies flashed simultaneously when I synchronized with one of the fireflies until its time interval brought it into coincidence with the other.

On the evenings of July 19 and 25, 1917, I had opportunity to carry the experimentation further—on each occasion with a single firefly. The same kind of results were obtained from these experiments. However, I discovered that when I brought the flashlight within 25 centimeters of the firefly it ceased flashing and did not recommence until after I had ceased flashing or until I had moved the flashlight back a meter or more.

On many evenings at the College of Agriculture of the University of the Philippines, at Los Baños, I have watched splendid fireflies, of which there are large numbers in the immediate vicinity. I frequently noticed that small trees and shrubs would be more aglow at certain times than at others, but I never happened to observe a time when a small tree or shrub was all alight one instant and dark the next. In my experience there were always some fireflies flashing in the "*dark*" periods. The times of greatest light occurred when the greatest number of varying flashes coincided.

From these observations and experiments it seems to me that complete synchronism in the flashing of a group of fireflies is simply a very rare accident, occurring when the flashes of the individuals chance to come at the same time.

Frank C. Gates

Carthage College,
Carthage, Ill.

UREDINIA OF CRONARTIUM RIBICOLA ON RIBES STEMS

During the past season uredinia of *Cronartium ribicola* Fischer have been discovered for the first time on *Ribes* stems. Three natural stem infections were observed on a plant of *Ribes hirtellum* Michx. (*Grossularia hirtella* (Michx.) Spach) growing in a pine woodlot at Kittery Point, Maine. In this same woodlot two other isolated plants of the same species, inoculated with æciospores by applying the moistened æciospores to the unwounded green stems, developed respectively one and seventeen stem infections. Of the seventeen infections some were very evidently natural infections since they occurred at points on the stems where no æciospores had been applied.

Uredinia were produced on some of the stem infections from the middle of June until August 20. The urediniospores which were formed in these sori were apparently normal in every way. In the case of the other stem infections, where no uredinia appeared, study of sectioned material showed an abundance of mycelium and numerous well-formed internal uredinia in the cortex.

The discovery of sporulating uredinia on *Ribes* stems complicates the already difficult problem of detecting the disease on *Ribes*. In view of the observations recorded above, it must be concluded that no *Ribes* from infected regions can be declared absolutely free from the rust even when completely defoliated. Moreover, the presence of the mycelium and internal uredinia in the stem tissue is strong evidence that the disease does in some cases winter over on *Ribes*.

G. B. POSEY,
G. F. GRAVATT,
R. H. COLLEY

OFFICE OF INVESTIGATIONS IN
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SCIENTIFIC BOOKS

Dioptrographic Tracings in Three Normæ of Ninety Australian Aboriginal Crania. By DRS. RICHARD J. A. BERRY and A. W. D. ROBERTSON. Transactions of the Royal Society of Victoria, Vol. VI., 1914.

The volume at hand contains 270 "life-size" tracings of crania of Australian natives. The number of skulls dealt with is ninety, each one being represented uniformly from the front, side and top. The publication follows one of a similar nature in which tracings were given of 52 Tasmanian skulls, by the same authors, and reviewed by the writer in SCIENCE of December 16, 1910.

As to derivations, the skulls utilized with six exceptions are all from the southeast part of Australia, *i. e.*, from the region south of the Murray River; the six exceptions are from Queensland.

The authors accompany the publication with the statement:

> We are solely desirous of making available to our scientific colleagues elsewhere, material of a valuable character, and which is otherwise inaccessible, and which runs the further risk of being lost in the process of time unless so collected. We do not desire to impose our own deductions derived from a study of this material upon those who may hold different opinions from ourselves, and hence we do not incorporate here, nor did we do so with the Tasmanian tracings, the result of our own observations on highly debatable questions, with the material itself. The conclusions which we ourselves drew from the Tasmanian material have been published in the *Proceedings of the Royal Society of Edinburgh*, Volume 31, 1910, and similarly the conclusions which it is our intention to deduce from the present material will be made available elsewhere, and in due course. Thus those who desire to make use of the present material for other purposes will have a free hand both now and for the future.

As in the case of the tracings of the Tasmanian crania, anthropologists are thankful to Drs. Berry and Robertson for their painstaking work; but as the Tasmanian volume so the one at hand presents certain serious deficiencies which are badly felt and which can scarcely be compensated for by any subsequent publication on the series.

In the first place there is no identification and subdivision of the specimens according to sex. They are evidently all of adults, yet even this is not certain. But the most serious deficiency is the omission of all measurements. An illustration without at least two or three of the principal measurements does not convey, a full measure of confidence. It is probable that the dimensions of the illustrations are perfectly true, but had a few measurements been given with each illustration this probability might have become a certainty.

The work incites, but does not satisfy; which should not be taken as criticism, but rather as a stimulus for the future. We need more than tracings. We need, in a most precise form, every possible detail concerning the cranium as well as the rest of the skeletal and physical make-up of the Australian; and may Drs. Berry and Robertson be soon in a position to give us this information.

Aleš Hrdlička

The Culture and Diseases of the Sweet Pea. By J. J. Taubenhaus. New York, E. P. Dutton & Co. Pp. xx + 232.

In the preface the announcement is made that this book is primarily intended to be a practical treatise for use by both growers of sweet peas and investigators. Those interested in the culture of this plant will no doubt find this book a very useful and helpful guide. It is among the few books which deal with both the culture and diseases of one particular crop. The author's reason for including both phases in the same treatise is naïve in that "the attack of most plant diseases depends on some weak point in the cultural methods which has weakened the host at some phase of its life history."

The first eighty-nine pages are devoted to explicit cultural directions which have been prepared for the author by specialists. The following ninety-five pages are given to a consideration of greenhouse and field troubles, including nine diseases of fungous origin, one of bacterial origin and a brief summary of the several insect pests. Due space is given in the closing chapters, in a clear, concise manner, to methods of prevention and control of these maladies.

The essential facts in the author's several important investigations on the diseases of sweet peas are summarized in this book, yet it is believed that the investigator would prefer to consult the original reports. The grower, himself, can best judge of the author's success in avoiding the use of technical terms. This same difficulty which confronts every teacher of elementary plant pathology has been encountered, and if one were to put himself in the position of the average reader he would find himself at times in a maze of meaningless terms. Certainly the person of less than collegiate training would find himself hopelessly lost if he attempted to wade through certain paragraphs in this book and at such points, one is even disposed to wonder what verbiage the author would have chosen had he purposed to use technical terms.

The binomial *Ascochyta pisi* Lib. was probably employed because it is better known than is the name for the ascigerous stage.

The book is well and amply illustrated, is unusually free from typographical errors and gives the impression of being condensed yet complete. It should have a place in the reference library of plant pathologists and of growers of sweet peas.

F. A. Wolf

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FIELD CONFERENCE OF CEREAL PATHOLOGISTS

The Third Annual Field Conference of Cereal Pathologists of the American Phytopathological Society was held at Madison, Wisconsin, on July 9, 10 and 11. About forty were in attendance at the various meetings. The following program was presented:

MONDAY, JULY 9

The forenoon was spent in visiting the plant pathology laboratories of the University of Wisconsin. In the afternoon, after a discussion by Dr. A. G. Johnson upon "Imperfect Fungi causing Cereal Diseases," the session was continued in the field, where Dr. Johnson's experimental plots were examined. In the evening a supper and smoker were given at the University Club, and in the round-table discussion which followed, the following discussions were given:

1. *Grass rusts and their rôle in cereal conservation;* Leaders, *Dr. J. C. Arthur, Dr. E. C. Stakman.* Dr. Arthur gave a historical dis-

cussion of rust work, with especial reference to his work in preparation of the rust section of the North American flora. Dr. Stakman pointed out five problems in the study of grass rust: (1) Biological specialization; (2) accurate knowledge of distribution of biologic forms in relation to rust epidemics; (3) the rôle of grass rusts in over-wintering uredinia; (4) the rôle of grass rusts in passing epidemics from the barberry to grain; (5) grasses acting as agencies for passing epidemics from one grain field to another.

2. *The relation of the barberry to rust epidemics;* Leaders, *Dr. E. M. Freeman, Dr. E. M. Wilcox.* In the absence of both of the above, Dr. Stakman led the discussion upon this topic also. Mr. Frank Piemeizel, who has charge of the Rust Survey now in progress in the Mississippi Valley, stated that the survey so far had indicated that stem rust overwinters in the extreme South in the uredinial stage, and that the amount of infection upon grain was found to decrease in passing from the south to the north. South of Ames, Iowa, no infection upon barberry was found, but north of that point no infection was found upon grain up to that time, except in the vicinity of affected barberry bushes.

3. *State and Federal legislation against the barberry;* Leaders, *Professor L. H. Bolley, Dr. L. R. Jones.* Professor Bolley reviewed the methods used in securing eradiction of barberry in North Dakota, which is the only state having a law declaring the barberry bush a nuisance. The work of eradicating the barberry bushes in North Dakota has almost been completed. Dr. Jones was unable to be present at the session.

TUESDAY, JULY 10

The forenoon was spent in visiting the farm near Madison operated by the Agronomy Department of the University of Wisconsin. In the afternoon the party went by auto from Madison, Wisconsin, to Watertown, Wisconsin, inspecting various grain fields on the way. In the evening a supper, smoker and round-table was held at the Commercial Hotel at Watertown. The following discussions were given:

1. *State and Federal cooperation in fighting cereal diseases during our food emergency;* Leaders, *Dr. H. B. Humphrey, Dr. F. L. Stevens, Dr. S. G. Kern.* Dr. Humphrey outlined a plan for campaign for eradication of preventable cereal smuts. This work, dependent upon the passage of the Food Bill, is to be done in cooperation with the Extension Service, and is to consist of two phases: first, publicity campaign, by means of the press, posters, etc.; second, men to be sent into the field to cooperate with the Extension Service in securing seed treatment. The subject of community seed treatment plans was also brought up for discussion. Dr. Kern spoke for the need of closer cooperation between the Federal and State Departments, and between states in their work, and of the value in correlating work upon general problems with local ones. Dr. Stevens was not present at the meeting.

2. *Recent investigations on yellow stripe rust; Charles W. Hungerford.* An account was given of work being carried on at Corvallis, Oregon, upon this disease.

WEDNESDAY, JULY 11

The day was spent in Juneau, Wisconsin, Beaverdam, Wisconsin, and on the farm of Mr. Kruger near Beaverdam. Meetings were held at the Court House in Juneau, and at the Mealy Hotel at Beaverdam. These meetings were open for general discussion and transaction of business.

The following business was transacted at the various meetings:

It was voted to have the secretary communicate with the Secretary of the Interstate Cereal Conference to arrange, if possible, to have the next meeting of Cereal Pathologists held at the same place as the Cereal Conference, with one day overlapping for joint meeting.

A committee consisting of Dr. L. R. Jones, Dr. H. B. Humphrey, drew up the following resolution, which was unanimously adopted:

TO THE HONORABLE,
THE SECRETARY OF AGRICULTURE.

We, the plant pathologists representing the chief grain-growing states in conference assembled, in recognition of the following facts:

1. The national and international need of the maximum production of all food grains for the immediate future.

2. The preventable losses resulting from smuts and other seed-borne diseases.

3. Practical and simple methods of seed treatment known to prevent such losses.

4. The Office of Cereal Investigations has already instigated a movement looking to the more universal treatment of seed for the prevention of these losses.

Resolve. (1) That it is our conviction that this work should be pushed with all possible diligence. (2) That we as representatives of these grain-growing states pledge to this work our hearty cooperation and support.

A committee consisting of Professor H. L. Bolley, Professor M. A. Carleton, and Dr. L. R. Jones, appointed to draft resolutions for the extermination of the barberry bushes, made the following report, which was accepted:

In view of the vital importance of the wheat crop, and as a national emergency measure likely to prove an effective aid in increasing and insuring a better wheat crop in 1918, be it resolved:

That we, the cereal pathologists of the American Phytopathological Society, in summer session assembled at Madison, Wisconsin, respectfully ask the President of the United States to appoint a commission to consider the relation of the barberry to outbreaks of black stem rust of wheat, barley, other cereals and grasses with a view of deciding upon the desirability of eradiction of all cereal rust-bearing strains of the barberry in the United States in order that this source of rust epidemics may be removed.

Be it further resolved that the Secretary be instructed to send a copy of this resolution to the President of the United States.

The following resolutions were also adopted by the Conference:

That the chairman of this body appoint a committee to take up with federal authorities the matter of securing some definite action to insure an adequate supply of fungicides and insecticides, particularly those containing copper, for the protection of important crops against the destruction of fungous diseases and insect pests and to insure a reasonable price for the same such as shall not be prohibitory to their use by the farmers and fruit growers of the United States.

To the Department of Plant Pathology and other Friends and Members of the University of Wisconsin:

Whereas, the cereal pathologists in meeting convened at Madison, Wisconsin, from July 9 to 11, were most hospitably entertained and assisted at their third annual meeting;

Resolved, that we extend our hearty thanks and express our due appreciation for your efforts in our behalf.

The following officers were elected for the ensuing year: Chairman, H. P. Barss. Secretary, C. W. Hungerford.

C. W. Hungerford,
Secretary

SPECIAL ARTICLES

THE POSSIBLE ORIGIN OF THE TOXICITY OF ULTRA-VIOLET LIGHT[1]

It is a general law of photochemical action that only those rays are effective which are absorbed by the system in which the reaction occurs.[2] Visible light-rays are not, as a general rule, selectively absorbed by protoplasm and hence their action is usually confined to specialized pigmented areas which constitute the receptive elements of optical sense-organs. Ultra-violet light, on the contrary, is generally highly toxic, even for colorless organisms, and since this toxicity presumably depends upon and is attributable to photochemical reactions the question presents itself to which constituent of the protoplasm are we to attribute the selective absorption of these rays which is the necessary precedent of their photochemical activity?

It was pointed out nearly forty years ago by Soret[3] that the majority of proteins exhibit a well-marked absorption-band in the ultra-violet spectrum. In seeking for the origin of this absorption-band Soret found that it is especially well exhibited by solutions of tyrosin, and therefore referred it to the tyrosin radical in the protein molecule. These observations have recently been greatly extended by Kober,[4] who has carried out a spectrographic examination of solutions of the various amino-acids which are the end-results of protein hydrolysis and of certain polypeptids. Kober has confirmed the existence of an absorption-band in the ultra-violet in solutions of tyrosin and also finds that a similar band is exhibited by solutions of phenylalanin. The other amino-acid constituents of the protein molecule exhibit only general (*i. e.*, non-selective) absorption in the ultra-violet spectrum.

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[1] From the department of biochemistry and pharmacology, Rudolph Spreckels Physiological Laboratory, University of California.

[2] Eder, "Handbuch der photographie," Halle, 1884, p. 28.

[3] J. L. Soret, *Arch. d. Sc. phys. et nat. Geneva*, 1878, pp. 322, 359; 1883, pp. 194, 204. A. d'Arsonval, *Arch. de Physiol. Norm et Path. Paris*, 1890, Sér. 5, T. 2, p. 340.

The possibility is thus indicated that the tyrosin and phenylalanin radicals of the proteins constitute the optical sensitizers which render living cells susceptible to the toxic action of ultra-violet light. If this were the case then passage of the light through solutions of proteins or the aromatic amino-acids should, by absorption of the toxic rays, to a greater or less extent deprive the light of its toxicity for protoplasm. With this possibility in view the following experiments were undertaken:

Definite volumes of a densely inhabited culture of paramecia were washed by suspending the organisms in tap-water and concentrating them by moderate centrifugalizations until a thick suspension of uninjured organisms in a colorless liquid was obtained. All of the suspensions used were prepared in exactly the same manner and were derived from the same culture.

Our first step was to determine what we have called the "normal extermination period," that is to say the duration of time in seconds of exposure to the direct rays of a Cooper-Hewitt Ultra-violet Light Type Z at a distance of 12 cm. from the quartz tube. For this purpose 0.5 c.c. of paramecium suspension was placed in a flat-bottomed (Syracuse) watch-glass and 0.5 c.c. of tap-water was added. Trials were made with varying times of exposure and the percentage of organisms killed was estimated by counting the individuals of which the cilia had ceased moving. The normal extermination-period was found, under these conditions, to be about 100 seconds. To determine whether the gases formed during the exposure to the ultra-violet light (ozone and nitric-oxide) hastened the killing of the organisms appreciably, a trial was made with a suspension protected from the ultra-violet rays by a thick glass plate, but still exposed to the gases. In this way it was determined that this factor could be overlooked, since after 900 seconds exposure no noticeable effect was observed.

After determining the normal extermination-period with the above procedure, trials were made with similar suspensions in solutios of Witte-peptone, gelatin, amino-acids, etc., the results of 160 such trials being summarized in the table below. Thus a 1 per cent. alanin suspension of paramœcia was prepared by adding 0.5 c.c. of a 2 per cent. solution of alanin to 0.5 c.c. of washed paramecium suspension.

The extermination-periods enumerated in the tables are meant to indicate that *immediately* after the stated period of exposure 100 per cent. of the organisms were dead. For it was found that even after an exposure as brief as 40 seconds in a water-suspension the organisms were affected and ultimately all died.

AVERAGE EXTERMINATION PERIODS

(*Paramecia immersed in Test Solution*)

Water suspension	100	secs.
1 per cent. cane sugar suspension	110	"
1 per cent. urea suspension	110	"
1 per cent. alanin suspension	110	"
1 per cent. leucin suspension	215	"
1 per cent. gelatin suspension	220	"
1 per cent. peptone suspension	300	"

Glutamic acid, amino-benzoic acid and aspartic acid all proved to be themselves toxic for the organisms and could not therefore be tested by this method. Tyrosin is very sparingly soluble in cold neutral water. A saturated solution, although exceedingly dilute, conferred marked protection, the extermination-period being lengthened to 180 seconds. An alkaline solution proved to be toxic and therefore could not be employed in this way.

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[4] P. A. Kober, *Journ. Biol. Chem.*, 22 (1915) p. 433.

In order to rule out the possibility that the protective action might be indirect, *i. e.*, not attributable to mere absorption of the toxic rays, and also to permit the employment of toxic acids the following modified procedure was employed:

In a quartz beaker with a diameter of 32 mm. 2 c.c. of the given acid were placed, this amount being just sufficient to completely cover the bottom of the beaker. A square piece of cardboard was placed on the Syracuse dish containing the paramecium suspension. The quartz beaker was then placed over a circular opening in the cardboard, having a diameter of 25 mm. By this means the organisms were shielded from all ultra-violet rays excepting those which passed through the solution in the quartz beaker. In order to fully expose all of the organisms and to standardize the depth of suspension, a paraffine mould was made in the Syracuse dish by holding a No. 3 rubber stopper in the center of the dish and pouring melted paraffine around it. On cooling, the stopper was withdrawn, leaving a depression 20 mm. in diameter in which 0.5 c.c. of paramecium suspension was placed.

Somewhat over 100 exposures were made, using this method with the following results:

AVERAGE EXTERMINATION PERIODS

(*Paramecia not immersed in Test Solution*)

Water	130	secs.
1 per cent. alanin	130	"
1 per cent. glycocoll	130	"
1 per cent. aspartic acid	130	"
1 per cent. glutamic acid	135	"
1 per cent. leucin	250	"
0.5 per cent. tyrosin	420	"
1 per cent. amino benzoic acid	2400	"

It will be noted that the results obtained by this procedure confirm those previously obtained by the method of immersion.

In order to obtain 1 per cent. solutions of tyrosin and cystin, which are very sparingly soluble in water, slight amounts of alkali were added to the test solution in the beaker and the extermination-periods after passage of the rays through alkaline solutions of these acids and of certain of the acids enumerated above were determined, with the following results:

AVERAGE EXTERMINATION PERIODS

(*Paramecia not immersed in Test Solution*)

0.5 per cent. NaOH	150	secs.
1 per cent. NaOH	170	"
1 per cent. glutamic acid in 1 per cent. NaOH	200	"
1 per cent. cystin in 0.5 per cent. NaOH.	1200	"
1 per cent. tyrosin in 0.2 per cent. NaOH	unaffected after 40 minutes exposure.	

We may infer that solutions of gelatine, peptone, amino-benzoic acid, cystin, tyrosin and leucin detoxicate ultra-violet rays which pass through them, while solutions of the other substances investigated do not appreciably do so. The protective action of tyrosin in alkaline solutions is exceptionally marked, and in this connection it is of especial interest to note that Kober has found that an alkaline reaction markedly increases the absorption of ultra-violet rays by tyrosin solutions.

The protective action of leucin, which does not exhibit a selective absorption in the ultra-violet, is at first sight somewhat puzzling. It was noticed, however, that both tyrosin and leucin solutions underwent a change of color upon continued exposure to the ultra-violet light. This change was especially marked in the leucin solutions resulting after 40 minutes exposure in closed quartz vessels in the production of a dark brown fluid having a distinctly intensified odor. This solution had a much greater protective power when tested in the above manner than leucin solutions which had not been previously exposed to the light. We may infer that ultra-violet light induces chemical changes in a leucin solution resulting in the production of substances having an enhanced power of absorbing ultra-violet rays.

Our results are therefore decidedly in harmony with the view that the susceptibility of protoplasm to ultra-violet light is conditioned by the selective absorption of the toxic rays by the aromatic amino-acid radicals of the proteins.

F. L. Harris,
H. S. Hoyt

University of California

SCIENCE

Friday, October 5, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

THE OUTLOOK IN CHEMISTRY IN THE UNITED STATES[1]

It is the highest privilege of the president of the American Chemical Society to express to you, citizens of Boston, the society's deep appreciation of your interest in our science and of your courtesy in providing entertainment for our numerous membership. In token of the reality of this appreciation, no less than in recognition of the honor bestowed upon me by you, my fellow members in the society, it is my pleasant duty to address you on some subject which might interest you as an important phase of chemistry or which might bring home to you as thoughtful citizens of this great country of ours some of the important functions which our science may be expected to fulfil in the life of the nation. It is the president's happy privilege also to select his own subject. In normal times, I confess, I should have enjoyed the pleasure the scientific man finds in riding his own hobby before a large and friendly public and I should have been tempted to try to present to you some phase of those wonderfully intricate worlds of atoms and molecules and of the forces controlling them, on which the peculiar power of our science rests. But the spirit of complete preoccupation in the great test to which our country is being put, which I know pervades the minds and souls of all of you, has led me rather to the choice of a subject of more immediate relation to our present situation. I have thought you might be interested in a discussion of the outlook in chemistry in the United States, with special reference to the resources of chemistry in the nation's service in war and in peace, as seen from the point of view both of chemical industry and of universities and colleges, the sources from which our chemists and our chemical lore are derived.

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[1] President's address delivered before the American Chemical Society, September 12, 1917, at Boston.

The great European war and now our own entry into the world struggle of free democracies against the organized military power of the last strongholds of feudal privilege in western civilization have brought home to the public as never before in the history of the world the vital place which chemistry occupies in the life of nations. What is it, indeed, that is so fundamental in this science that a country's very existence in times of great emergencies and its prosperity at any time may depend on its master minds in chemistry? It is the fact, summed up in the fewest possible words, that *chemistry is the science of the transformation of matter.* Since every phase of our existence is bound up with matter, from our birth to our return to dust, we find at every turn in life that chemistry is in demand to aid man in his effort to assure to himself a safe, scientific control in the supplying of his own needs, where nature, from time immemorial, has shown the same impersonal indifference as to his wants, his survival or destruction, that she has for every other form of life! From the transformation of our raw ores into finished metals of almost any conceivable quality and application, to the transformation of rocks and salts and the gases of our atmosphere into nourishing foods, from the transformation of the yield of our peaceful cotton fields and rich coal deposits into death-dealing explosives, to the preparation of blessed life-saving medicaments from the same crude sources—to mention only a few instances of the transformation of matter that I have in mind—it is chemistry that is giving us the power to satisfy our needs, whether it be for wise and beneficent purposes or for the fulfilment of our more baneful desires.

The crisis of the war has put this great controlling science, as it has put all other human agencies, to the fire test in every great country on the face of the earth. Acknowledgedly, chemistry has thus far staved off defeat for Germany after Joffre on the Marne had killed her hopes for a swift, crushing victory through the violation of Belgium, and had taught her that she must face a long struggle, in which, cut off from the world's supplies, she must make shift with what her own territories could yield and her chemists could produce. In the wonderful organization of power in France and in England in the midst of war, the French and English chemists have stepped in and brought their supplies of munitions of every variety, of remedies, of their new weapons of defense and offense in poison gas and liquid fire warfare up to the point of meeting now on more than equal terms an enemy prepared years in advance. And in our country too our chemists have stood the ordeal of an unprecedented time. I have in mind our splendid achievement of having solved in these three years of warfare such tremendous problems which these years have brought to us as were involved in the speeding up of the production of thousands and thousands of tons of fundamental chemical products needed by our allies and now for our own purposes—steel and iron alloys of every variety of toughness, hardness or elasticity, purified copper by the millions of pounds, aluminium for airships and motor cars, abrasives on which the trueness of every great and every small gun depends, sulphuric acid and alcohol for the preparation of explosives—foods, oils and scores of other essential products prepared on a scale never seen before—I think we may say with justifiable pride that our great basic chemical industries have successfully risen to the demands of a situation unparalleled in its scope and urgency. There have been times of delay and times of worry, but the few failures have been due rather to financial difficulties than to a breakdown in scientific efficiency. To those of us who know that the chemist is the final controlling mind, guiding in safety for the financier these vast undertakings and expansions, the record of these years is truly a wonderfully satisfactory response to the first crucial test of the efficiency of chemistry in America.

And this result justifies the faith that we will win out just as surely in the hundreds of newer problems brought to us by our own participation in the war. Some of these problems have been brought to the attention of our members by the chairman of the two chief chemistry committees, which are cooperating with the government—Dr. W. H. Nichols, chairman of the committee on chemistry of the National Defense Council, an industrial committee, and by Dr. M. T. Bogert, chairman of the chemistry committee of the National Research Council, a research committee. From San Francisco to Boston, from Minnesota to Texas, our chemists have shown the all-pervading desire to bring to the immediate practical assistance of our country every ounce of our strength and every grain of our intelligence, and have stepped into line for service not only with splendid enthusiasm, but still better, with the grim determination of purposeful men, who know well our enemies' strength, but who will do our share to eliminate, effectively, unscrupulous militarism from the politics of the world! The immediate response to the tender of the services of our membership to the President of the United States and of the organization of the members for such service through a census of chemists has been an increase in our membership from a total of some 8,000 to 10,500, an unprecedented growth, which shows unequivocally that the chemists of the United States are of one mind in ranging themselves on the side of organized, whole-hearted and forceful support of our government in this war! Indeed, one of our chief difficulties has been to restrain our men in their eagerness until proper organization would enable the central committees to designate to each man the field in which he could serve best. To the impatient chemists, waiting for their "marching orders" it may have appeared that invaluable time has been wasted and that progress even now is all too slow. But work on all the most important problems really was quickly organized and already important results are available. As an illustration of this fact we have the brilliant and speedy success of Dr. Day and his collaborators in producing optical glass, so much needed for range-finders, which will bring our shots home to the enemy.

The very nature of most of the problems makes it impossible to name them here, but I may say that improvements in explosives, multiplication of the sources of supply from which to manufacture explosives, including the utilization of the atmospheric nitrogen for the production of nitric acid, providing protection for our soldiers and sailors against poisonous gases, the making of chemicals for which we have hitherto been dependent on importations, these are some of the problems on which many of our ablest chemists have been working with all the power and concentration that the occasion demands. I may be more explicit in regard to the problem of the home manufacture of so-called synthetic remedies, for the supplies of which up to the present time we have turned to our present enemies. We need large supplies of salvarsan for our hospitals and for our armies, we need local anesthetics, substitutes for cocaine, for our surgeons, we need safe hypnotics to insure blessed sleep to sufferers in home or hospital, we need a long list of products to relieve the numberless ailments to which man is subject. Many of the best of these products are protected by patents, but the Adamson law will make it possible for American manufacturers to prepare these remedies in this country. There is nothing wonderful about their preparation—the scientific skill and experience of American chemists is coping with them as easily as an expert chess-player solves his problem in chess—and indeed with much the same kind of enjoyment. For instance, the obstacles in the way of the preparation of some drugs, most needed but prepared with considerable difficulty, such as salvarsan and atophan, have already been overcome in a way that leaves no doubt, if any ever existed, as to our ability to stand on our own feet, once Congress has removed the legal disabilities. University men and industrial firms have united in the vigorous attack on this problem.

This question brings me to another phase of my subject. Looking beyond the immediate future to the years ahead, why should we ever again be dependent on any foreign country for such fundamental needs of a nation as the best remedies for its stricken people—or, enlarging the question—for such fundamental industrial needs as dyes and dozens of finer chemicals, the need of which has seriously handicapped manufacturers and to a certain extent is still interfering with normal activity? It has been publicly urged in Germany—I am quoting from an excellent article by our friend Dr. Baekeland—that German dye manufacturers after the war should allow only a limited and conditional quantity of dyes to go to foreign countries, including the United States, in order to give her home industries a great lead in recovering the commerce of the world in textiles. Even if this suggestion should not be put into effect, for Germany has more to lose than to gain by a policy of trade-war after the reestablishment of peace, we may be sure that her own manufacturers will get the best of her supplies and every possible advantage. Our textile manufacturers and many other branches of industry will be at the mercy of competitors, assisted by government direction, unless we have a declaration of chemical independence in this country! Every thoughtful chemist, I am convinced, and I trust that every other thoughtful citizen, will acquiesce in the policy that henceforth in our *basic* needs, at least, we be independent of the friendship or enmity of foreign nations! And that conclusion brings me to one of the most important points in my discussion this evening: What are some of the main conditions, from a chemist's point of view, that must be fulfilled, if we are to look forward to successful industrial and scientific development and independence, when the tremendous competition of peace must be met. These conditions are to be sought not only in the field of applied chemistry—and applied chemistry includes every great national industry, from agriculture to the manufacture of steel—but they involve also our universities, technical schools and colleges, the great sources from which our chemists come, not only equipped technically for their work, but carrying also the inspiration, the orientation, which will make or mar them and with them will make or mar that part of the nation's life which will be dependent on chemistry.

Turning first to the field of applied chemistry, I would like to emphasize that in my opinion the most important single factor which would lead to a tremendous increase in power in our industrial development is not immediately a question of scientific achievement, but a factor found in a simple psychological analysis of our industrial situation. Let our manufacturers but awaken to the great significance, to the full meaning of the simple old behest that the laborer is worthy of his hire, and they will be astounded at the results. American manufacturers at present on the whole do not treat their chemists, and especially their research and directing chemists, fairly. The tendency is to exploit the chemist as an employee, instead of treating him as a partner, who brings scientific experience, skill and acumen to the aid of capital and commercial experience and standing. Manufacturers are willing to cooperate essentially on the footing of partners with great lawyers, who solve their legal difficulties—usually a wholly sterile performance as far as the welfare of the nation as a whole is concerned—but they have not yet learned to cooperate in the same fashion with men of our profession, who solve their technical difficulties to the direct enhancement of the nation's wealth and welfare! Our chemists know and feel that they are being exploited and in conscious or unconscious resentment, after one bitter disappointment or the other in their employers' fairness, they lose their fresh enthusiasm and their capacity for the whole-hearted, unstinting effort that goes with the work in which the heart and soul support the mind! All this is wrong. Research and managing chemists should be sure that success means partnership in the fruits of their success, that success will yield immediately and not in some hazy future of a soon-forgotten promise, an equitable share in the actual benefits of the work done. This is one of the real but unrecognized sources of the unquestioned leadership of Germany in fields chemical: Dr. Bernthsen, director of the Badische Anilin-Fabrik, probably the greatest of the many great German firms, told me some fifteen years ago that from the lowliest workman up to the highest chemist in his employ, every individual is guaranteed by contract a royalty, a definite share in the money earned or saved by any suggestion or discovery on the part of the individual. Contrast this wise policy with what is common knowledge concerning the situation in the great majority of American plants. Any chemist can multiply indefinitely the single specific illustration of this attitude that I will give. One of our doctors of philosophy of the University of Chicago, as chief chemist for one of the very largest manufacturing concerns in the country—a unit in a "trust"—perfected a device, simple in itself, that saved the corporation perhaps $80,000 a year · his reward was a princely increase of $200 or $300 a year in salary! Incidentally, let me say that I promptly took him away from this corporation—we can not afford to waste good men in such places. In case after case that has come to my notice from some of our leading men, chemists have been cuddled and patronized until their improvements have been completed and then recognition has come munificently in the form of a few hundred dollars a year and—oblivion. These men, leading men, let me remind you, have acknowledged to me that this treatment killed outright all the fire of enthusiasm with which they had been wont to work! There are a few noteworthy exceptions among corporations, but their strength and prosperity confirm the validity of the appeal I am making, for they have recognized that in large measure their continued prosperity has been the result of the brain-work of their chemists, cooperating with the brain-work of their directors and the capital of their corporations. There are also prominent exceptions among individual chemists: we have men in our Society who have worked their way to positions and incomes on a par with those of successful lawyers and physicians—but manufacturers should heed well that almost invariably these are men who withdrew from their original direct employment by corporations and have developed their own independent establishments, either as consulting chemists or as independent, competing manufacturers! How much wiser it would have been for the manufacturers —I am not saying, for the chemists—if these brilliant, forceful men had been kept in their establishments, as they would have been abroad, by fair treatment as partners in success as well as in effort.

I have dwelt long on this plea because I consider this message to our manufacturers from an outside observer, a university man without any industrial affiliations, to be perhaps the most important service I can try to render our country in this privileged address. Let me summarize my point with the aid of an analogy which I owe to my friend Dr. Eisenschiml's remarks after a presentation of this subject to our local section in Chicago: Just as Napoleon let every soldier feel that he carried a marshal's baton in his knapsack and thus secured the enthusiastic and self-sacrificing support of his hundreds of thousands, so our manufacturers should let their chemists feel that each one carries in his brains a contract of partnership—and all that is involved therein! If this is done, we will witness through the tremendous power of the combination of psychological momentum and trained, scientific minds, the dawn of an era of power and prosperity in our industries, in which no one need fear the after-the-war competition for which all Europe is now preparing. Enlightened self-interest is slowly revolutionizing and improving our whole social fabric by a fairer, more honest conception of the relation of capital to workers—with harm to no one, least of all, and to their own surprise, to those who have blindly been opposing the movement. And my plea for fairer treatment of productive chemists is the point at which the great world movement touches our scientific body.

Another vitally important factor in the outlook for chemistry in the United States is the adoption by our legislative bodies of a definite national policy looking toward the establishment of that independence of our country in the matter of chemical supplies to which reference was made before. Action in this direction has been happily inaugurated in the fundamental matter of the fixation of atmospheric nitrogen for the manufacture of explosives in war times, of fertilizers in peace and war. The fixation of nitrogen plants in Germany have unquestionably saved her thus far both from a military collapse and from starvation. As has been indicated before, it is important too that we become independent in as large a measure as possible also in regard to all manufactured chemicals and particularly also the finer organic chemicals, including the dyes and the synthetic drugs. The most important measure necessary to this end is protection by duties such as a non-partisan commission of experts may find necessary. American textile manufacturers, who have opposed this action in the past as far as dyes are concerned, have, I trust, learned their lesson, and will not, I hope, need a second more sharply pointed one. And other manufacturers, having found their supplies of needed chemicals cut off or enormously increased in cost, will also, I imagine, favor the establishment of conditions making home production possible. It is a source of gratification to me to state that the United States Tariff Commission, which is making a scientific study of the vexed tariff problem, most courteously asked for, and received, the coöperation of this society in the choice of an unprejudiced expert on the chemical schedules.

Wise patent legislation is another fundamental consideration in a declaration of chemical independence. The public—that is, their representatives in Washington—should understand what is obvious to any professional student of the problem, namely, that independence is altogether a question of capital, not of science—of dollars, not of chemists. Our unqualified success in every line of applied chemistry in which investment of capital has been an attractive proposition is positive evidence that we have the chemists and the knowledge to achieve this independence, if wise legislation by tariff and patent laws will insure to capital a return sufficiently attractive and stable to have it enter these needed fields.

To illustrate concretely what this policy would mean for the nation let us consider the following: Much more than a question of coloring materials is concerned in a conscious policy to have our dye industries established on a permanent basis. It has often been emphasized that the manufacture of dyes is so closely related to the preparation of explosives that a flourishing dye industry in times of peace means ample facilities for explosives in times of war. No American would care to contemplate what our position would be in the matter of large scale production of explosives if we had become engaged in a struggle with a first class power without the benefit of the great expansion in our dye and explosives factories which our commerce with England and France brought about after 1914! When peace comes, let no American forget this lesson! One way of insuring ourselves against a lack of facilities for a sudden expansion in the production of explosives is to keep capital invested in dye factories.

Independence in the preparation of medicinal remedies, especially also of the finer modern products which we call synthetic drugs, should be as conscious an aim of the United States as independence in the manufacture of dyes. It is worth noting that the two aims support each other, for nearly all of the basic products needed for the large scale preparation of synthetic remedies are either prepared in aniline dye factories as intermediate steps toward the dyes or are so closely related to such compounds that it would be a mere detail to include these products in the normal output of a dye factory. As an instance pointing in this direction, recent correspondence with a prominent American firm, which has invented and is manufacturing what promises to be a valuable substitute for cocaine in producing local anesthesia, brought out the fact that the chief difficulty in the way of the production of the drug on the large scale which the situation demands, lies in the securing of sufficient quantities of the chemicals diethylaniline and cinnamic acid. Now, the former could and should be manufactured in dye factories with the greatest of ease, side by side with dimethylaniline, which is a common intermediate in the manufacture of many dyes, and cinnamic acid could be prepared from benzaldehyde, another intermediate. Furthermore, large research departments in well-organized dye factories will be centers of research in applied organic chemistry and practically all of our valuable synthetic drugs are such organic compounds. Indeed, it will be a matter of time only—and I should like to see that time shortened as much as possible—when some of our best equipped and most progressive dye factories will turn to the problem of these remedies as a question of the economic utilization of their equipment.

That has been the history abroad and it will be the same here. In fact, together with our long-established great pharmaceutical houses, they should find even richer, unexploited fields of effort in the problems of synthetic drugs than in those of dyes. Without question the average man spends on necessary drugs for his family at least a thousandfold the value of the dyes in the wardrobes of his whole family—the ladies, of course, included. The twitchings of rheumatism or gout, sleepless nights or a cantankerous cold are most urgent and persuasive drawers on a family purse. My professional friends in the audience know well how the modern dye industry has been built up on an accurate scientific knowledge of the connection between color and what we call the structure of the molecules, those minute worlds on the knowledge of which our power to reconstruct matter rests. We know too that the dye industry has reached, or almost reached, its full maturity and capacity. But we are only on the threshold of exactly the same kind of development in the discovery of improved remedies for curing human ills because the connection between the structure of our molecular worlds and their medicinal effect is just beginning to be systematically elaborated. Great industrial establishments founded on organic chemistry, like the dye manufacturing and the great pharmaceutical houses, collaborating with research laboratories in universities and in medical institutes, would hold out to this country the promise of a share in realizing a duplication of the conquest of the world of color, which has occurred in the last fifty years, by the greater conquest of the world of scientific medicine! A brilliant beginning has been made in this campaign by the preparation of excellent substitutes for cocaine, less toxic than cocaine itself—by the elaboration of salvarsan, by the isolation in our own country, and the artificial production, of adrenalin, a vital regulating principle produced by an organ, the suprarenal capsule, in our bodies. The isolation and exhaustive study by Kendall of the active principle of the thyroid gland, which no doubt will be followed by its artificial preparation, is a second brilliant instance of American success in this great field! When we consider the countless number of animal preparations—gland extracts, serums and antitoxins—the pure active principles of which are all we really want, but which are injected into us or fed to us, with an extraordinary amount of unnecessary and often harmful animal matter, we can realize what a boon to humanity this line of effort really means. Let me emphasize again, it is chiefly a matter of wise and foresighted legislation to make our independence and perhaps our leadership in this great field possible—we have proved that we have the scientific ability—it is a question only of putting this work on the basis of an established industry!

There are other important considerations bearing on the outlook for chemistry in the United States from the point of view of industrial chemistry—such as a law making possible commercial agreements and divisions of labor among competing houses, which exist abroad—but I must neglect no longer to turn to the third important theme embraced in my subject, the outlook for chemistry from the point of view of our universities and colleges, in which I will include the outlook for the development of the theory of our science in this country.

One can not well overestimate the importance of the standing of chemistry in our universities and colleges: they are not only the main sources of supply of chemists in the United States, but they are also the fountain-heads for the knowledge which keeps us in touch with the progress of chemistry the world over and which makes available for rapid absorption in any field of pure or applied chemistry new discoveries, new methods of attack, new, clarifying points of view. Let me remind you that applied chemistry includes not only industrial chemistry, but also fundamental and most promising fields of effort in other major sciences. Botany through the inspiration of Liebig was probably the first of our sister sciences to apply chemistry to the solution of many of its problems. Physiology followed and now we see even zoology awakening under the stimulus of chemistry from its long morphological trance to a live science of animal life. In fulfilment of the promise contained in the life of our great fellow-chemist Pasteur, chemistry is now at last guiding not only the physiologists, but also the bacteriologists, pathologists and laboratory clinicians toward the raising of medicine from the uncertain realm of art to the safer one of science. All life is indeed but a transformation of matter in its loftiest phase and the world is at last realizing that the fundamental science of the transformation of matter holds the key which should unlock the secrets of all aspects of life, of birth, health, disease and death, and probably even of such subtler manifestations as heredity and character.

I have outlined some of these far reaching applications of chemistry in order to emphasize the fact that if we are to meet all of these demands on chemistry, if the outlook not for chemistry alone, but for all of these lines of human progress which are dependent on our science is to be one of sure promise in the United States, it behooves our people to see that the departments of chemistry in our universities and colleges be kept not only prolific as to the output of men—the vast expansion in laboratories and attendance bears witness to quantity being insured if the war does not affect us too severely—but that they also be maintained on such a high level of scientific quality that the product will consist of the very best type of men! We have received from the period from which we are now passing a magnificent heritage of world standing and ideals in our university life. The last twenty-five years witnessed an era of expansion of our resources for research and instruction, of the raising of standards of scholarship and productivity of such moment that many years before the war began the migration of our students, especially also of our chemistry students, to Europe for the pursuit of graduate work and the securing of the highest type of professional training had practically ceased. It has no longer been a question of Berlin or Munich, of Goettingen or Heidelberg; for the prospective chemistry student it has been a choice of Harvard or John Hopkins, of Chicago or Columbia, of Illinois or California, the Massachusetts Institute of Technology or Cornell—I could extend the list much longer, but fear it would tire you. And it has been so because our young men have felt that they could secure just as thorough an education here as there, just as inspiring guidance from men whose research had made them masters in their own fields. Our Remsens and Michaels, our Richardses and Nefs, our Noyeses and Gombergs, Lewises and Morses—to mention only a few of our leaders of this period—founded that independence in university education in chemistry which our country has the right to demand that we maintain.

Now, thoughtful men in our society, looking ahead, see that this great uplift in our scientific life is facing dangers which unless they are met frankly and effectively, will bring on a period of depression which will be a grave menace to all the varied fundamental interests in the life of the nation that depend on chemistry.

The first and greatest of these menacing developments has its root in the recent unprecedented demand of our industries on our schools for research men. From university after university, from college after college, the combined lure of great research opportunities and of much larger financial returns has taken from our academic life far too many of our most promising young men, the very men on whom the country has been depending for the filling of our great university chairs as the older men now holding them gradually will age and retire. Unless prompt measures are taken we shall witness in a few years such a dearth of first-class tried material for professorships that second-rate men will be placed where the national welfare needs the best we have, and third- and fourth-rate men will be occupying positions in which we should have young men of the highest promise in the period in which they are reaching full maturity. Indeed, it is greatly to be feared that even now we are witnessing a gradual lowering of standards. It would be futile to appeal to our industries not to call the men they need, although in the not distant future they will suffer most severely from the situation which is developing, if the present tendencies remain unchecked. The only possible source of relief lies, I believe, with the presidents and trustees of our great universities, and to these the second main plea of this privileged discussion is addressed. These authorities should recognize the fact that their institutions have now entered a period of severe competition between the industries and academic life for chemists of the highest type and greatest promise. They have already learned the only method of meeting this kind of competition successfully, for they have faced the same problem in two other professions, medicine and law: in the face of the tremendous financial attractions of the practise of either of these professions our most progressive universities have simply put their law and their medical faculties on a higher, more nearly professional scale of endowment of professorships than obtains for their other faculties. They must, it seems to me, take the same measures with their chemistry staffs: it is primarily a question whether they can be awakened to that need now or whether they will let the country suffer from their lack of foresight and let us learn from the most efficient of our teachers, bitter experience. Wise provision now would not only safeguard our present standing in a critical period of our history, but in this time when the importance of chemistry has been brought home to our young men as never before, the new attitude, properly announced, would attract a large proportion of the men of brains, talent and ambition who enter professional life, but tend to study law or medicine as holding out much greater opportunities for the satisfying of their ambitions.

Adequate compensation is important for a research man—and to his type in university and college I must restrict my remarks—it is important both from the point of view of his self-respect and also especially for the sake of comparative freedom from worry concerning a fair provision for his family. But inadequate compensation is not the only danger seriously threatening the outlook for chemistry in our universities. Let us remember that healthy progress in our science is dependent primarily on university men pursuing great lines of original investigation. It is true that we now have well-endowed national institutions of research, such as the Rockefeller Institute and the Carnegie Institution, but universities can not afford to surrender to these the main burden of insuring progress in the theory of our science, because these *are not teaching* institutions. To take from our universities the choicest of our research men would deprive our young men of that inspiration and fertilization of their minds in the period of their greatest acceptiveness which early intimate association with great investigators alone can give. To my mind it is clear that if universities would fulfil their highest mission they must remain the seats of the best type of research. But such research is the product of an extraordinarily sensitive state of mind. Only the greatest powers of concentration of thought make it possible. The investigator is groping for truth in unexplored regions, wary of every pitfall, most fearful indeed of possible illusions of his own highly excited imagination. Let any one imagine himself groping in a dark and unfamiliar room and he will easily realize that the undisturbed concentration of his every faculty is the only way for him to attain his goal! Let the rush of an automobile or the screech of a locomotive detract his attention but for an instant and he may well have to rue a stubbed toe or a grazed shin! Now, figuratively speaking, there are too many noisy automobiles and screeching locomotives in the lives of our distracted investigators. American universities, in general, have the unfortunate custom of loading down their best investigators as heads of departments with administrative duties of all varieties, ranging from clerical functions to committee work, important for the institution, but always a grave obstacle in the path of successful research. Younger men, even when they show marked research ability, are too often worn out with excessive duties of instruction and laboratory detail, when their minds need their keenest edge to cut their path to the elusive truth! Men in whom the research instinct is inborn and overpoweringly intense, will break through these difficulties—usually at the cost of the neglect of other duties—but our system is one that means an extraordinary waste of talent for the highest type of work on duties that minds of lesser fineness could do just as well or better. On top of these older defects, which we have been only slowly recognizing and removing, have come in the last few years the further distracting duties of necessary public service. Let me repeat what I stated earlier in the evening: every one of our great chemists, as well as of our less well known ones, is eager to devote every particle of his knowledge and strength to the sacred duty of the moment. Theoretical work has been set aside except as it contributes directly to the cause of national defense. But let us begin to realize now that when peace comes we must let our investigators return to the service of pure science, we must leave them severely alone, free from committee work of any kind, so that they may recover that opportunity for concentration which is needed for productive research of permanent value! Some of our research men, I dare say, are being spoiled forever for this service, exactly as many a returning soldier will have lost in a craving for adventure his fitness for ordinary civic responsibilities.

There is a strong movement too in our society to bring universities and industries into closer relations, a laudable movement with which I am in heartiest sympathy, but which can bring unmixed benefits only if it is most wisely guided. It would be fatal if it were allowed for the sake of temporary advantage to injure in any way that search for truth for the sake of the truth itself on which, after all, the great structure of our science as of all sciences rests. Let the large proportion of members in our society who are primarily interested in applied chemistry, recall as a typical illustration of a very general truth that chemists had tried for fifty years to manufacture sulphuric acid by the contact process and had utterly failed, and that success finally came only when the laws of physical chemistry, products of the research of guileless university professors, were available and were applied to the problem! Who can doubt that we still need the efforts of new Faradays, van't Hoffs, Roozebooms, Bertholets, Kekules! The question has impressed me as so vital a one for the outlook for chemistry in this country that as president of our society I have put on the committee charged with the development of relations between industries and the universities primarily university research men, with the understanding that they will give to pure research in our universities the benefit of every doubt in their recommendations. I trust that our society, as a whole, will realize that it were better that our industries suffer somewhat temporarily than that our national strength in chemistry be crippled at the source. My personal opinion is that we can attain both of our objectives—to use a war phrase. Thus, our present war duties are making university men personally acquainted with numerous practical problems which in many cases after the war, will probably form the basic material for investigations of theoretical relations. Even if they are only in a measure as successful as those of Baeyer, when through the study of the structure and synthesis of indigo he opened up the great theoretical fields of knowledge of tautomerism, of the theory of unsaturated compounds and of cyclic derivatives, they will advance both branches of our science, applied and theoretical chemistry. Efforts along the lines of developing the theory of the connection between molecular structure and physiological or medicinal properties are now taking root in a number of our universities. But, on the whole, I would recommend that technical research problems—routine analytical and control work should be altogether barred from our universities—that technical research problems be limited in universities to picked men interested in applied chemistry and holding possibly professorships or other appointments in industrial chemistry. In time, these men will become dependent on their colleagues devoted to pure science for keeping step with the progress in our science. I would urge, too, the perhaps novel recommendation that remuneration for such work be made a departmental and not an individual affair. This wise provision is being enforced in those modern medical schools which demand research work of their staffs, fees for practise reverting to the university hospitals and not to the individual. As applied to chemistry, such a provision would be desirable, in the first place, because it would to a large extent reduce the temptation of financial inducements for the men whose talents fit them for work in pure science and whom the country needs for such work. In the second place, one will find that the university man interested in a technical problem is, after all, less useful in a teaching department than the man devoted to pure research: the pressure from outside will lead him to throw a greater mass of administrative detail, of instruction or of the care of research men, on his colleagues. The result is that the department and not the individual really carries the burden of the problem in applied chemistry—exactly as in the medical schools, which still allow their staffs to practise for their own financial benefit, this is all too often done with the drawbacks of inefficient teaching, the ignoring of administrative responsibilities and the leaving to the care of others the provisions for education in research.

I have dwelt on the details of this great problem which is confronting our society, because I would protect the outlook for the growth and success of theoretical chemistry in our country by every means in my power. We have a splendid record: we are easily leaders in the domain of knowledge based on the exact determinations of atomic weights—a knowledge which leads among other results to habits of more exact, more critical methods in all fields of our science. Arrhenius told us that America is leading in the difficult work of the rigorous examination of the theory of ionization and of establishing it on a finished basis. The development of the field of free energy relations is more intensely cultivated, here I imagine, than in any other country. In the application of modern theories of atomic structure and of the electron theory of valence to all branches of chemistry, especially also to organic chemistry, we are, I believe, easily in the front. Our very youth, as a people, has preserved to us in science as in national sentiment, that wholehearted enthusiasm for ideals, which in world politics has made us the most altruistic nation on the face of the earth and which in science finds its expression in the pursuit of knowledge for the sake of the pure truth alone, a pursuit characteristic of the best research in our universities and colleges!

And so let me conclude my remarks on the outlook for chemistry in America by emphasizing that we have a goodly heritage of success both in our great industries and in our great universities, which will form the safe basis of a brilliant future, if we will but approach the problems of the moment and of the immediate future in characteristically American fashion, with a spirit wisely combining altruistic principles with practical, worldly common sense. This means the "square deal" in industrial life for the product of the brains of the research chemist, combined with wise laws to insure to capital a fair and tolerably safe return for investment in chemical industries, needed to make our country chemically independent. And it means too the placing of chemistry in our universities on a plane with the other great professions, law and medicine, in order to hold in this great science, so important for the welfare of the nation, the needed numbers of men of brilliant minds and energetic ambitions—combined with the devotion on their part to the search for the truth, for the establishment of the great laws of our science, for the sake of that truth, that science, alone!

JULIUS STIEGLITZ

UNIVERSITY OF CHICAGO

SCIENTIFIC EVENTS

THE LANE MEDICAL LECTURES

THE sixteenth course of Lane Medical Lectures at Stanford University will be delivered by Simon Flexner, M.D., LL.D., director of laboratories, Rockefeller Institute for Medical Research, New York City, N. Y., on the evenings of October 8, 9, 10, 11, and 12, 1917, at 8:15 o'clock in Lane Hall, Stanford University Medical School, San Francisco, California, on "Physical basis and present status of specific serum and drug therapy."

The titles of the separate lectures are as follows:

October 8: Epidemic Meningitis; Lobar Pneumonia; Bacillary Dysentery and Specificity in Bactericidal Sera.

October 9: Gaseous Gangrene; Shiga Bacillary Dysentery, and the Principles of Homoserum Therapy.

October 10: Poliomyelitis and the Principles of Homoserum Therapy.

October 11: Local Specific Therapy as illustrated by the Serum Treatment of Epidemic Meningitis, Poliomyelitis and Tetanus.

October 12: Chemotherapy of the Spirochetal Infections.

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

DURING the season from October, 1917, to April, 1918, inclusive, the Anthropological Society of Washington, D. C., will provide a very interesting program of papers or lectures chiefly concerned with divers nations of Europe and the East now at war or likely to be involved before long, including especially some of our less known and smaller allies. The general plan of most of these monographs will be a résumé of earliest known data, racial origins, shiftings and blendings, historical development and present status, aiming to further a more thorough acquaintance with these peoples, their characteristics and capabilities and the causes which have made them what they are. The appended schedule may be subject to some changes in detail as the season advances and is now necessarily incomplete as to one or two items, but will give a sufficient idea of what is to be expected. The society meets at 4.30 P.M. in rooms 42–43 of the new building of the National Museum on alternate Tuesdays, beginning October 2d, 1917.

PROGRAM

October 2. Dr. Aleš Hrdlička, Bohemia and the Bohemians.

October 16. Dr. Mitchell Carroll, The Story of Greece.

November 6. Professor James H. Gore, Belgium.

November 20. Mr. George J. Zolnay, Roumania, Past and Present.

December 4. Dr. Amandus Johnson, Scandinavia; Mr. Juul Dieserud, Certain Customs of Norway.

December 18. France.

January 15. Dr. Voyslav M. Yovanovitch, Serbia.

January 29. Voyslav M. Yovanovitch, Italy.

February 12. Dr. Joseph Dunn, Scotland.

February 26. Dr. B. Israeli, Russia.

March 12. Mr. E. T. Williams, The Origin of China.

March 26. Mr. E. T. Williams, Holland.

April 9. Dr. Paul Haupt, Mesopotamia and Palestine.

April 22. Annual meeting and election of officers.

Some, perhaps, most, of these lectures will be illustrated by lantern slides or otherwise. The public will be welcome.

WM. H. BABCOCK, *President*

EFFECTS OF THE WAR ON TECHNICAL EDUCATION

WALTER HUMPHREYS, registrar of the Massachusetts Institute of Technology, has compiled registration statistics which indicate the effects of the war on technical education. The total registration is between eighty-five and ninety per cent. of what it was last year at the same time. The freshman year shows an increase, the percentage in terms of last year's figure being 104, while the second, third and fourth years classes are respectively 93 per cent., 75 per cent. and 86 per cent., of the number in the school in June.

The graduate students stand at 60 per cent. of last year's figure. There is the most shrinkage in the juniors, the sophomores of last year, to whom two years more of schooling has perhaps seemed a long time. The return of eighty-six per cent. of the juniors to be seniors is evidence in favor of the junior summer camp. The purpose of this was to give some military practise and an opportunity to anticipate fourth-year studies, and complete work at an earlier date.

In a consideration of the effect on the courses it may be well to omit those with less than fifty men, since the defection of a few students makes an undue percentage shrinkage. One of them, however, naval architecture, is stimulated by the war, the increase being 16 per cent. The course in naval architecture has always been small in attendance and has been maintained by the institute as a contribution to education.

Of the larger courses civil engineering maintains practically the same figure as in former years, the shrinkage being 1.2 per cent., while electrical engineering opens the year with a loss of only 2 per cent. Chemical engineering has 12 per cent. increase. Engineering administration is practically holding its own, having lost only six and one half per cent. since the last registration. Architecture has declined nearly one third in the number of its students. Perhaps the undue cost of building materials, fifty to one hundred per cent. in many cases, and the consequent gossip that building operations will be at a standstill, has had its influence in deterring young men from taking it up with usual vigor. Mechanical engineering has lost about 21 per cent. This is a study that should be stimulated by the war. In this work Professor Miller, head of the department, has undertaken for the U. S. Shipping Board the management of the schools for marine engine-room officers in the principal ports in the country.

WORK OF THE NATIONAL RESEARCH COUNCIL

Upon recommendation of the National Research Council Dr. Augustus Trowbridge, of Princeton University, and Professor Theodore Lyman, of Harvard University, have received commissions in the Signal Corps, U. S. A., for work in sound ranging. They have sailed for France to investigate conditions at the front in this subject. The sound ranging service which will be developed under their direction will utilize in the near future more than fifty men. Captain Horatio B. Williams is in charge of the development work in this country during Major Trowbridge's absence.

A meteorological service has been organized under the Signal Corps, U. S. A., in which about one hundred physicists and engineers will be engaged in aerological observational work under the direction of Dr. William H. Blair, of the U. S. Weather Bureau, who has received a commission of major and has sailed for France to investigate conditions abroad. Forecasting work for the American Expeditionary Force in France will be in charge of Mr. E. H. Bowie, of the U. S. Weather Bureau, who has likewise received a commission of major in the Signal Corps and is already on his way to France. Major Bowie will be assisted by Mr. R. Hanson Weightman, of the U. S. Weather Bureau, who has received a commission as lieutenant in the Signal Corps.

Professor Charles E. Mendenhall, of the University of Wisconsin, has received a commission of major in the Signal Corps, U. S. A., and has been placed in charge of the development of aeronautical instruments.

All of the work of these services, sound-ranging, meteorology and aeronautical instruments, is included within the scope of the Science and Research Division of the Signal Corps, which in accordance with a recent order of the chief signal officer has been established and placed under the direction of the National Research Council, of which Major R. A. Millikan is the executive officer. The functions of this division of the Signal Corps are two-fold, namely: (1) to furnish personnel of the research sort to the other divisions when the situation warrants the assignment of men of this type to these divisions, and (2) to have a personnel of its own which maintains intimate contact with all research and development work in other divisions, and distributes research problems to university, industrial and governmental research laboratories with which it is associated. Similar, though in some cases less formal, relations have been established with other technical bureaus of the War and Navy Departments.

Upon request of the French High Commission a number of American physicists and chemists are being sent to France to assist in various war problems in which technically trained men are needed. Except in certain cases, the Interministerial Commission in Paris will assign them to work in university laboratories and in technical services of the government. Upon recommendation of the National Research Council the following men are receiving commissions in this connection and a number of them have already sailed for France:

Professor R. W. Wood, of Johns Hopkins University, major in the U. S. Signal Corps.

Messrs. Roy W. Chestnut, Leonard Loeb and Samuel Sewall, lieutenants in the U. S. Signal Corps.

Professor Edward Bartow, of the University of Illinois, major, and Professor Reston Stevenson, of the College of the City of New York, captain in the U. S. Sanitary Corps.

Messrs. Ralph L. Brown, of the University of Chicago, George Scatchard, of Columbia University, and Kirke W. Cushing, of Western Reserve University, lieutenants in the U. S. Sanitary Corps.

SCIENTIFIC NOTES AND NEWS

The trustees of Columbia University have dismissed Professor J. McKeen Cattell from the chair of psychology which he has held since 1891, on account of a letter which he addressed to members of the Congress, asking them to support a measure which had been introduced against sending conscripts to fight in Europe against their will. Professor Cattell has given out a statement in which he says that he is opposed to war and to this war, but that he has engaged in no agitation against the government, and has not written anything opposing conscription or against sending an army abroad. He maintains that forcing "conscientious objectors" to fight in Europe is not only contrary to democratic principles, but also subversive of the efficiency of the army and of national unity. He claims that it is the duty as well as the constitutional right of a citizen to petition the government to enact legislation believed by him to be for the national welfare. For a university to dismiss a professor for doing this is both unjust and illegal. Under the circumstances Professor Cattell believes that it may be in the interest of SCIENCE and of the American Association for the Advancement of Science for him to retire from the editorship which he has held for twenty-two years. He has addressed a letter to the chairman of the Committee on Policy of the Association requesting that a successor be selected.

AT Peking the cornerstone of the hospital and medical college of the Rockefeller Foundation was laid on September 24 by Fan Yuen-Lien, minister of education. Dr. Paul Reinsch, the American minister, presided at the exercises, which were attended by Admiral Austin Knight, commander of the American Asiatic fleet. Dr. Frank Billings, chief of the American Red Cross mission to Russia, who is now in Peking, made the principal address.

PROFESSOR JOHN S. SHEARER, of the department of physics of Cornell University, has received a commission as major in the National Army. Since the declaration of war, Professor Shearer has been on duty at the Cornell University Medical College in New York City, instructing officers of the Medical Corps and the Medical Reserve Corps in roentgenology, and conducting conferences for the standardization of X-ray apparatus.

LEAVES of absence for the year 1917–18 were granted by the administration committee of Cornell University to Professor George Young, Jr., of the college of architecture, and Professor Ernest Merritt, of the department of physics, who are engaged in work for the government, to L. L. Silverman, instructor in mathematics, who is in the service of the committee of public safety of the state of Massachusetts; to Professor Samuel N. Spring, of the department of forestry, in order that he may serve as a captain in the 20th Engineer (Forestry) Regiment, and to Professor Allyn A. Young, of the department of economics, to permit him to serve as chief of war trade statistics in the Division of Export Licenses at Washington.

AT the University of North Dakota there has been established a research committee to cooperate with the National Research Council in connection with the advancement of a variety of problems of scientific and practical interest. The committee consists of Dr. Earle J. Babcock, chairman, dean of the engineering colleges and professor of industrial chemistry; Dr. J. M. Gillette, professor of sociology; Dr. George A. Abbott, professor of chemistry; Dr. A. G. Leonard, professor of geology, and Dr. Charles E. King, professor of physiology.

J. W. BAILEY has resigned an assistant professorship in zoology at the Agricultural College of Mississippi to undertake research work for the U. S. Department of Agriculture, with headquarters at Tempe, Arizona.

DR. MINNIE A. GRAHAM has resigned her position as instructor in analytical chemistry at Wellesley College to act as abstracter for the research department of the General Chemical Company in New York.

DR. HERBERT C. MOFFITT, dean of the University of California Medical School, has been called into active service as a major in the Medical Officers' Reserve Corps, and is stationed at the Army Hospital at San Antonio, Texas.

DR. W. A. PERLZWEIG, assistant professor in biochemistry in the Creighton University College of Medicine, has been appointed first lieutenant in the Sanitary Corps of the army.

At the opening exercises of Columbia University, Dr. Cassius J. Keyser, of Columbia University, gave the address, the subject of which was "The enterprise of democracy." The address of the College of Physicians and Surgeons was given by Dr. Hans Zinsser, professor of bacteriology, his subject being "Medicine, the great opportunity."

Senor Augusto Villanueva, Santiago de Chile, has become a member of the Ramsay Memorial Committee for Chile.

Edward Booth, assistant professor of chemistry in the University of California, died at his home in Berkeley on August 23.

Lieutenant-Colonel T. H. Boardman, who had charge of the work in physics at Christ's Hospital, London, died of wounds on August 4 while on active service in the army.

Dr. J. R. Tosh, lately assistant professor of zoology in St. Andrews University, has died in Mesoptamia from "heat stroke."

As already announced, the thirty-second general meeting of the American Electrochemical Society is being held in Pittsburgh from October 3 to 6. *The Metallurgical and Chemical Engineering* states that a special feature of the meeting will be a series of papers and discussions on electrochemical war supplies, and the part the electrochemical industry will play in the present struggle. The committee in charge is outlining an elaborate program of technical sessions, visits to industrial plants and entertainment features. It invites the delegates to arrive in Pittsburgh on Wednesday, October 2, so as to meet informally and enjoy some recreations which have been planned for them. On Thursday, October 3, a regular meeting of the society will be held in the morning, with optional excursions to industrial plants in the afternoon. In the evening an illustrated lecture on a semi-technical subject will be given. On Friday, October 4, a symposium on electrochemical war supplies will be held in the morning, followed by excursions to industrial plants in the afternoon. A subscription dinner will be held at the William Penn Hotel in the evening. Saturday, October 5, will be devoted to an all-day excursion, on a special train with complimentary luncheon, to several industrial plants in the Pittsburgh district."

According to the London correspondent of the *Journal* of the American Medical Association official statistics show that on an average there has been an increase in food prices of 104 per cent. compared with July, 1914, the month before the war began. The increase varies from 65 per cent. in the case of fresh butter to 191 per cent. in the case of certain parts of frozen mutton. The average price of bread—23 cents for the 4-pound loaf—is double that in July, 1914, and flour shows a proportionately greater advance, amounting to 109 per cent. The price of granulated sugar had risen over the war period from an average of about 4 cents to nearly 12 cents per pound, but increased duty accounts for about 2.5 cents of the rise. The average price of cheese is slightly more than double than in July, 1914; that of eggs, slightly less than double. The price of tea is 74 per cent. higher, but about half of the advance is due to increased taxation. Butter and margarin show increases approximating to 65 and 74 per cent., respectively, over pre-war prices. Milk prices had risen 60 per cent., or 4 cents per quart. In arriving at the general percentage increase, the several articles are weighted in accordance with the proportionate expenditure on them in pre-war family budgets, no allowance being made for the economies resulting from changes in dietary which have been effected since the beginning of the war, especially in those families in which the total income has not been increased by advances in rates of wages, greater regularity of employment, increased output, or the working of overtime. As an illustration of possible economies in this direction, if eggs are omitted from the dietary, margarin substituted for butter, and the consumption of sugar and fish reduced to one half of that prevailing before the war, the general percentage increase since July, 1914, instead of being 104, would be 72. During last month alone the general level of retail prices of the principal articles of food rose about 1 per cent. The prices of British beef increased appointed lecturer in anatomy at the Johns Hopkins University.

DISCUSSION AND CORRESPONDENCE

WHEN IS A FORCE NOT A FORCE?

In his communication to Science for March 16, 1917, Mr. A. H. Patterson very pertinently calls attention to the vagueness, lack of precision and error in the treatment of the force concept by current physics text-books. Much of Mr. Patterson's criticism deals with Newton's third law of motion and appears to be based on a misinterpretation of that law. To this I wish to call attention.

Force is always exerted by one portion of matter, *A*, upon a second portion of matter *B*. These may be distinct bodies or parts of the same body. If *A* exerts a force on *B* then, the third law tells us, *B* exerts an equal force in the opposite direction on *A*. If the force of *A* on *B* *is* called the action, the force of *B* on *A* is called the reaction. The action and reaction do not act on the same body or body-part. Failure to fully appreciate this seems to be responsible for the present as well as many other misinterpretations of the third law.

Mr. Patterson asks: "What is a student to think when he is told that to *every* action there is *always* an equal and contrary action, and is then informed that (only) an unbalanced force acting on a mass produces acceleration?" The two statements are mutually consistent and true. In order to safeguard the student against some of the pitfalls which are dangerous even to his teachers it is only necessary to make the information more complete.

Mr. Patterson's problems may well serve this purpose. The ball at the end of a rubber band is the first of these. Let us ignore the effect of gravity. When the ball is whirled about in a circular path at uniform speed the pull exerted by the rubber band *on the ball* is called the centripetal force. No other balanced force and gives rise to an acceleration which manifests itself in the change in direction of the velocity. The equal and contrary action is the outward pull of the ball *on the string*, known as the centrifugal force. The string is not accelerated because the pull of the support at the fixed end is equal and opposite to the centrifugal pull at the free end. The forces on the string are balanced.

A porter pushes a truck at uniform speed over level ground. Then the force which he exerts forward on the truck is equal to the backward frictional force. If this frictional resistance were suddenly to vanish, the forward force exerted on the truck by the porter would be the only horizontal force, hence unbalanced and a forward acceleration would result. Both with and without friction the truck pushes backward on the porter with an equal force. In addition to pushing forward on the truck the porter is pushing backward on the ground with his feet, and consequently the ground is pushing him forward. If the forward push of the ground and the backward push of the truck are equal the forces on the porter are balanced and he moves without acceleration. Everywhere the forces act in pairs, because there must be an exerter of the force and a body on which it is exerted. Newton's law has a meaning only when both bodies are considered.

Newton's third law requires no distinction between inertia-reactions and other forces. To introduce them serves to complicate rather than to simplify. The following problem utilizes Mr. Patterson's method, quoting freely from the closing paragraphs of his communication.

A mass *M* rests on a perfectly smooth horizontal surface. To *M* we apply a horizontal force *F*. Being the only horizontal force it is unbalanced. It is opposed by an inertia reaction *which can in a sense balance it, but can not hold it in equilibrium because a force opposed only by inertia reaction always produces acceleration.*

It is difficult to see the need of this devitalized form of the third law, either from the point of view of principle or of practice. Forces do always exist in pairs, yet the forces on either or both of two bodies between which force-action exists may be unbalanced.

Mr. Patterson assumes a contradiction where none exists and then proposes an artificial way out.

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THE THIRD LAW OF MOTION AND "INERTIA REACTION"

The recent article by Mr. Andrew H. Patterson in Science for March 16, 1917, impels me to add to the discussion of questions in mechanics something that I have tried to make clear to students. It is along the line of Mr. Fulcher's article of November 24, and concerns the confusion between the third law of motion, the second law, and D'Alembert's principle.

Mr. Patterson appears to object to teaching that "to every action there is always an equal and contrary action" or that "forces always occur in pairs" and at the same time that an "unbalanced force" produces an acceleration. There is surely no inconsistency in this, since the "pairs" of forces or the action and reaction act on different bodies, say A and B, then if no other bodies are acting upon them, there will be an unbalanced force on each, and each will be accelerated, but in opposite directions. Evidently another pair of forces may act between B and C such that on the whole the forces on B exactly balance, and yet A will be left with an accelerated motion. On the other hand, while it is clear from writing the equation representing the second law of motion in the form $F - Ma = 0$, that *if* a force equal to the mass times the acceleration *should* act on the body in the opposite direction to the impressed force, these forces would be in equilibrium, this is not a case of the third law, which specifies that the forces considered act between two bodies and not on one and the same body. If for a system one adds the idea (D'Alembert's principle?), that the internal actions and reactions of any system of bodies are in equilibrium among themselves, a special case of the third law, one obtains the more general statement that *if* forces equal to the several masses times their respective accelerations *were* applied, etc., a form which is useful in the handling of problems, but which does not imply that such forces *are* acting and does not call for the idea of "inertia reactions."

The case where "inertia reaction" is most frequently drawn in, in connection with action and reaction is the instance of an object being whirled around on the end of a string. Now when one explains the motion of the moon about the earth as due to the action of the gravitational force on the moon directed towards the earth, one looks for the "reaction" in a gravitational force on the earth directed toward the moon, but not a force on the moon, and this reaction on the earth has nothing to do with the mass × acceleration of the moon, but would be the same if the moon were at rest in the position which it has at any instant. Is not the same true for the ball and string? Consider the case where a person grasps the ball by a hook at the end of a diameter, and pulls on a cord at the other end with the force F, the ball as well as the cord is strained, and we may say that the ball is pulling on the string and the string on the ball (the third law), in virtue of this strain. Now let go at the one end, in order to continue to apply a force F the hand must be moved with the same acceleration which the ball has in order to keep the string stretched, and would not the ball in the neighborhood of the string remain strained as before and hence the forces between ball and string be of the same nature as before? Now suppose the ball swung around the head, as Mr. Patterson suggests, would not the ball still remain strained and would it not pull on the string with a force which would be exactly the same as if the ball were at rest, but in the same state of strain? If so why bring in an inertia reaction? In the illustration of the porter pushing a cart, as long as he *actually pushes* there is an equal counter force *on him*, but in the one case the push on the cart may be balanced by friction, and in the other it would be an unbalanced force on the cart. Actually if friction suddenly ceased would not the porter probably notice that the force with which he was pushing had suddenly diminished, and that he had to hurry up to push at all! It would seem to me to be true in this case also that the push back on him would be the same if the cart were in the same state of strain and at rest.

If the point of view brought forward here is correct it would seem to me desirable to leave out of any elementary discussion of mechanics an "inertia reaction."

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AN ADDITIONAL NOTE ON "THE OOLITIC AND PISOLITIC BARITE FROM THE SARATOGA OIL FIELD, TEXAS"

About three years ago the writer wrote a description of some barite of unusual type from the Saratoga Oil Field, Texas.[1] Specimens of this mineral have been brought to the surface in pumping, and they have been found, in all cases reported to the writer, at a depth around 1,200 feet, indicating that they probably have their source in a definite geological horizon. At the time the above-mentioned paper was written it was supposed that the concretions of this mineral originated with the sands in which they were found but there was no definite information on the subject.

In discussing this matter a short time ago with Mr. E. G. Woodruff, he stated that at least some of these concretions undoubtedly formed in the wells after they were equipped, because they had been found reaching a quarter of an inch in diameter, in a well with a screen on the tubing, the mesh of which was altogether too small to admit a concretion of the size stated. He kindly sent the writer an assortment of specimens of various shapes and sizes from other wells in the same field as those previously described and of approximately of the same depth. Tests with the blow-pipe and specific gravity determinations show that the composition of the concretions is almost identical to that of those previously described. A number were examined for nuclei, but in most cases no definite nucleus could be found. When a nucleus is present it consists of earthy material made up mostly of clay and barite and this mass is often stained with iron ioxide which gives the center of the concentration a brownish tint.

This additional information is interesting from the standpoint of its bearing on the origin of concretions. It would appear to be practically impossible for bacteria or other low types of life, which are believed to play an important part in the origin of oölites, to exist in a liquid with such strong antiseptic properties as those of warm petroleum containing considerable sulphuric acid. It would seem to demonstrate that living organisms are not essenial to the development of oölites and that these may form where precipitation is taking place in an agitated solution, in the absence of life.

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SCIENTIFIC BOOKS

Ocean Magnetic Observations, 1905–1916, and Reports on Special Researches. By L. A. Bauer, Director, with the collaboration of W. J. Peters, J. A. Fleming, J. P. Ault and W. F. G. Swann. Washington, D. C., 1917. Carnegie Institution. Pp. vii + 447.

This large and handsome volume is the third of the series issued by the department of terrestrial magnetism of the Carnegie Institution and contains full reports of all the magnetic work of the department at sea during the past eleven years The two preceding volumes deal with the observations on land for the periods 1905–1910 and 1910–1913 respectively.

In 1905 the wooden brigantine *Galilee* was chartered at San Francisco and fitted up for magnetic observations with the purpose of making a preliminary survey of the Pacific Ocean which was at that time "nearly a blank as regards magnetic observations." In the course of three years, this vessel cruised 63,834 nautical miles and, magnetically speaking, put the Pacific Ocean "on the map." In addition to the great number of valuable and accurate observations which were accumulated, these cruises of the *Galilee* afforded an opportunity for testing and improving magnetic instruments adapted to sea-conditions, for establishing a practicable and suitable routine of observing and of checking instruments and in general for learning how to make magnetic observations at sea far more accurately and systematically than had ever before been attempted.

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[1] Oölitic and Pisolitic Barite from the Saratoga Oil Field, Texas,'' by E. S. Moore, *Bull. of the Geol. Soc. of Amer.*, Vol. 25, pp. 77–79, 1914.

The "magnetic constants" of this wooden sailing vessel were smaller than those of any vessel which had been previously used for magnetic observations; but, small as they were, they necessitated many corrections and frequent "swinging the ship" to obtain the accuracy which Dr. Bauer had determined upon as the goal to be attained. This not only consumed much time, but also diminished the precision of the final results. Accordingly, the non-magnetic yacht *Carnegie* was built in 1909 in which the use of iron was almost wholly avoided; wooden pins, and bolts of copper and of Tobin bronze took the place of iron nails, the producer gas engine used for auxiliary power was constructed of bronze, and the only magnetic materials used were the steel valves, piston rings and cam-rollers. Repeated tests have shown that this unique vessel has no appreciable effect upon the instruments; and in her various cruises aggregating more than 160,000 miles, observations have been obtained with comparative ease and rapidity whose accuracy is far beyond anything which had previously been possible at sea.

The first 154 pages of the present volume give an account of the work done on the *Galilee*, while the remainder deals in the same way with the observations made on the *Carnegie*. The various instruments are fully described and illustrated, and it is most interesting to follow their gradual improvement and perfection. To the experimental physicist this is one of the most attractive portions of the report; especial mention may be made of the beautiful and ingenious marine earth-inductor described on pp. 196 et seq. A full account is given of the methods of making observations, their reduction and correction and of the system of checks and controls between the various instruments, as well as those introduced by shore observations which were made at every opportunity. The final results for each cruise are given in tabular form and no detail is omitted which might add to their usefulness.

In addition to the magnetic measurements, systematic observations were also carried out on atmospheric electricity, ionization and radio-activity; these form the subjects of the special reports with which the volume closes.

The practical utility of this great series of magnetic observations in correcting mariners' charts of magnetic variation is obvious; serious errors in the present charts have been found and their correction lessens the dangers of navigation in times of storm and fog when astronomical observations are impossible. And quite apart from this most useful result the ultimate scientific value of such a survey continued year after year, as it will doubtless be when the war is over, is very great. The earth's magnetism is one of the great mysteries of physical and cosmical science; observations on land alone cover too small an area of the earth's surface to afford an adequate basis of knowledge of the earth's field and of the intricacies of its secular variations. Continued, systematic sea observations of the accuracy of those recorded in this report form a necessary stage in the solution of the great problem; when that is obtained it will doubtless lead to a further knowledge of the sun's magnetism and may well have results of the highest significance in cosmical theory.

This volume is a monument to the well-directed enthusiasm and foresight of Dr. Bauer and to the skill and zeal of his associates. In this case as in many others the Carnegie Institution deserves the thanks of the scientific world for generously supporting and wisely forwarding work which could scarcely have been done at present by any other agency.

H. A. BUMSTEAD

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THE RELATION OF THE MALPIGHIAN TUBULES OF THE HIND INTESTINE IN THE HONEYBEE LARVA

IT has been known for nearly a hundred years that the mid-intestine of larvæ of bees and wasps was essentially a blind sac.[1] The subsequent establishment of communication between the mid and hind-intestine in the larvæ of various members of the Hymenoptera was long since noted and has been studied in detail by Rengel.[2] The relation of the Malpighian tubules to the hind-intestine in the Hymenoptera has, on the other hand, been strangely neglected, being mentioned only incidentally or completely ignored. For example, both Anglas[3] and Rengel merely state that in the late larva or semipupa of the honeybee the Malpighian tubules open into the hind-intestine, and ignore the earlier stages. Karawaiew[4] and Perez[5] describe the Malpighian tubules in the ant larva as opening into the hind-intestine. This condition, however, does not obtain in case of the feeding larva of the honeybee, the central (caudal) ends of the tubules being blind from the time of hatching up to the sealing of the cell. The relation of the tubules to the hind- and mid-intestine during the feeding period is briefly as follows: The posterior end or fundus of the mid-intestine is, as already stated, completely closed, the epithelium being continuous here. The cephalic end of the hind-intestine is enlarged and the mouth of this enlargement closed by a thin diaphragm-like layer of cells continuous marginally with the wall of the hind-intestine The central part of this diaphragm-like structure is closely applied to the external surface of the fundus of the mid-intestine which is here devoid of a muscular coat. The pointed central blind ends of the four Malpighian tubules are inserted between these two layers, two on each side, but their tips do not extend quite to the center of the area of attachment of the mid- and hind-intestines.

In the newly hatched larva the Malpighian tubules are slender tubes, and pursue a winding course from their point of attachment up to the second or third thoracic segment, lying between the capacious mid-intestine and the body wall. Their lumen is minute, the walls being relatively very thick and composed of cells whose depth and breadth are approximately equal. In the mature larva on the other hand the Malpighian tubules are relatively voluminous, attaining, near their posterior ends, a diameter greater than that of the hind-intestine. The posterior or central ends themselves, however, always remain of small diameter Sections through the tubules at this stage show that the walls are extremely thin and composed of flat cells. In fact, the tubules might well be described as "thin-walled tubular sacs." Evidences of distension by internal pressure are obvious.

After the larva has been sealed up in its cell by a waxen capping both the fundus of the mid-intestine and the diaphragm-like epithelium closing the cephalic end of the mid-intestine become perforated, thus establishing an avenue of communication between the mid- and hind-intestine through which the fæcal accumulations of the mid-intestine are expelled. At the same time that this occurs each of the Malpighian tubules establishes connection with the hind-intestine by means of a fine canal which perforates the diaphragm-like layer of cells which formerly closed the anterior end of the hind-intestine but which now forms an annular structure uniting the mid- and hind-intestines. Sections through the tubules show that they have greatly diminished in calibre, the walls being more or less collapsed and their component cells being correspondingly narrower and deeper.

The history of the Malpighian tubules and that of the mid-intestine during the feeding period of larval life are therefore parallel in that both, in addition ,to performing their original functions, retain and store up the accumulated excreta which is discharged only after feeding ceases, when such discharge on the interior of the cell occupied by the larva would not involve contamination of the food.

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[1] Dutrochet, R. J. H., "Mémoire sur les métamorphoses du canal alimentaire chez les Insectes," *Jour. de Phys.*, LXXXVI., 1818.

[2] Rengel, C., "Uber den Zusammenhang von Mitteldarm und Enddarm bei den Larven der aculeaten Hymenopteren," *Zeit. wiss. Zool.*, LXXV., 1902.

[3] Anglas, M. J., "Observations sur les métamorphoses internes de la Guepe et de l'Abeille," *Bull. Sci. France et Belg.*, XXXIV., 1901.

[4] Karawaiew, W., "Die nachembryonale Entwicklung von *Lasius flavus*," *Zeit. wiss. Zool.*, LXIV., 1898.

[5] Pérez, Ch., "Contribution a l'étude des métamorphoses," *Bull. Sci. France et Belg.*, XXXVII., 1903.

Jas. A. Nelson

Bureau of Entomology,
Washington, D. C.,
July 18, 1917

SPECIAL ARTICLES

CONCERNING THE EFFECT OF INGESTED PLACENTA ON THE GROWTH-PROMOTING PROPERTIES OF HUMAN MILK

It has been shown that the feeding of desiccated placenta to women during the first eleven days after parturition causes an increase in the protein and lactose per cent. of the milk.[1]

The present report is concerned with the growth of the infants subsisting upon the milk from the above sources. As a basis for comparison there is used the growth of the infants whose nourishment was derived from the women whose milk production was not subjected to the influence of ingested desiccated placenta.

In the tables at the end of this paper the number assigned to the infant corresponds to the number given to the mother in the previous reports.[1] It should be remembered that all the mothers were receiving the same diet and that to the second set 0.6 gm. of desiccated placenta was fed three times a day throughout the period.

Certain definite differences in the progress of growth of the two sets of infants are to be observed.

The variation limit per cent. from day to day, and the absolute per cent. variation from day to day is less in degree and tends to take on more of a positive character in those infants whose mothers were fed the desiccated placenta. Also the per cent. variation from the first day, both as regards its limits and its average is at all times less in degree. The general trend of these latter values is towards zero; this is not to be seen with the infants receiving milk from uninfluenced sources.

It is evident that the recovery from the postnatal decline in weight is hastened by the consumption of milk produced under the influence of maternally ingested placenta.

It is obviously possible to eliminate from consideration the increase in protein and sugar production induced by the placental feeding as the cause of the early weight increase.

TABLE I

The Weights during the First Eleven Days after Birth of the Infants receiving Milk from the Mothers whose Production was Uninfluenced by the Ingestion of Desiccated Placenta

Infant No	1, Oz	2, Oz.	3, Oz	4, Oz	5, Oz	6, Oz	7, Oz	8, Oz.
Day 1	118	148	120	120	119	104	96	144
2	108	138	116	111	114	98	91	143
3	107	130	114	107	112	100	94	131
4	109	129	109	110	106	102	94	135
5	106	129	112	111	105	104	100	134
6	105	132	114	104	106	104	96	134
7	108	131	112	104	108	104	98	141
8	108	130	108	102	107	107	91	143
9	105	129	109	105	108	104	91	149
10	108	128	108	112	103	107	93	146
11	108	120	108	114	104	107	96	148

TABLE II

The Weights during the First Eleven Days after Birth of the Infants receiving Milk from the Mothers whose Production was Influenced by the Ingestion of Desiccated Placenta

Infant No.	1, Oz.	2, Oz	3, Oz.	4, Oz	5, Oz.	6, Oz.	7, Oz	8, Oz.
Day 1	150	119	111	135	144	76	114	123
2	138	115	108	123	142	72	112	117
3	133	112	101	123	136	71	107	121
4	134	112	100	123	136	72	108	122
5	140	113	99	124	138	72	110	119
6	140	114	100	123	143	72	106	126
7	142	115	100	124	146	73	104	126
8	145	118	102	124	147	76	106	124
9	149	118	101	124	144	76	108	118
10	153	116	99	128	144	75	106	126
11	150	116	98	130	143	75	108	126

These results may then be best interpreted on the assumption of the presence of some growth-promoting factor in the ingested placenta, which has been passed on to the infants in the milk. There is thus opened up the probability of the placenta taking some part in intra-uterine growth aside from its function as a transfer system.

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[1] Hammett, F. S., and L. G. McNeile, *Jour. Biol. Chem.*, 1917, XXX.; Hammett, F. S., *Jour. Biol. Chem.*, 1917, XXIX., 381.

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THE EFFECT OF DRAINAGE ON SOIL ACIDITY

For the purpose of studying the effect of drainage on soil acidity, samples of soil were taken in October, 1916, from three of the experiment fields of the Purdue Agricultural Experiment Station. These fields are located near Westport, North Vernon and Worthington. The soils of these fields are all heavy silt loam, very low in organic matter and naturally poorly drained and quite acid in reaction. All of these fields have been thoroughly tile drained from three to five years. A portion of the Westport field is undrained and there are adjacent undrained, untreated areas alongside the North Vernon and the Worthington fields.

TABLE I

RELATIVE ACIDITY OF DRAINED AND UNDRAINED SOILS

Field and Soil Treatment	Lbs. $CaCO_3$ Needed per 2,000,000 Lbs. Soil	
	Drained	Undrained
Westport field.		
Limestone....	40 #	760 #
Limestone, phosphate and potash	30 #	360 #
Untreated....	860 #	1,280 #
North Vernon field.		
Untreated....................	1,880 #	2,840 #
Worthington field:		
Untreated	740 #	1,600 #

Table I. shows the acidity of the soil as determined by the potassium nitrate method. Without entering into a discussion of the merits of different soil acidity methods, it may be said that on these soils, which are low in organic matter, there is no great difference in the degree of acidity shown by this method and the lime water and calcium salt methods. These results are consistent enough to indicate that drainage has a material influence on the acidity of soil of this type.

Farmers often refer to wet, poorly drained land as sour. While agricultural writers have placed little or no emphasis on such a correlation, it is quite probable that soils in general will tend to become less acid when thoroughly drained, and vice versa; they will tend to become more acid when water-logged and poorly aerated. In testing soil acidity at different seasons of the year the results often vary quite a little in samples from the same plots of soil. These differences can not be attributed altogether to errors in sampling. The writer believes that at least part of the change of acidity is due to difference in aeration and moisture content of the soil at different seasons. Lipman and Waynick,[1] in an investigation of the effect of climate on soil properties, report that Maryland soil, which shows an acid reaction in its original location, when transported to Kansas or to California becomes neutral or slightly alkaline. It is quite probable that the better drainage and aeration of the soil when placed under less humid conditions could account very largely for the changes in reaction.

Considering SiO_2 an acid-forming oxide, practically all soils except those very high in the basic reacting elements, have a potentially great capacity for developing an acid reaction.

The writer believes that the constitution of the silicates of aluminum has more to do with injurious soil acidity than any other single factor. The acidity of aluminum silicates varies both with the relative proportion of SiO_2 to Al_2O_3 and with the amount of combined water in the silicate.[2] The weathering and changing of soil silicates under poorly drained or well-drained conditions would undoubtedly vary the constitution of the silicates and also vary the degree of soil acidity. It is quite true that certain types of well-drained sandy soils are acid. It is true also that a number of other factors besides drainage conditions affect soil acidity, but it is probable that the most acid soils are formed in poorly drained areas.

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[1] Lipman, C. B., and Waynick, D. D., *Soil Science*, Vol. I., No. 1, p. 5, 1916.

[2] Conner, S. D., "Acid Soils and the Effect of Acid Phosphate and Other Fertilizers upon Them," *Jour. Ind. and Eng. Chem.*, Vol. VII., No. 1, p. 35, 1916.

SCIENCE

FRIDAY, OCTOBER 12, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

RADIATION AND MATTER[1]

WE must congratulate ourselves upon the fact that we have been able to listen to such clear, concise and accurate presentations of the most fundamental problems that lie before pure science to-day. I would like, also, to extend to the speakers our sincere thanks for their efforts in giving us such interesting expositions of these abstruse theories.

It is my privilege to open the discussion on radiation and the structure of matter. Modern theories of radiation are largely concerned with Planck's conception of the radiation of energy in quanta, and with the extraordinary action constant usually denoted by the letter "*h*." I would like to present for your discussion some ideas on the relations between the high frequency vibrations which we observe in general *X*-radiation, and the forces holding the electrons and atoms together, including a physical conception of what this constant "*h*" really means.

Instead of basing the discussion on the conceptions of entropy, and thermo-dynamic probability, I shall start from our recent experiments on general *X*-radiation.

Before we learned from experiments that *X*-rays had definite wave-lengths, people supposed that they had, and that we could calculate their frequencies by the formula kinetic energy equals $h\nu$.

$$\tfrac{1}{2} m v^2 = h\nu. \tag{1}$$

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[1] Presented at the symposium on "The Structure of Matter" at a joint meeting of the Sections of Physics and Chemistry of the American Association for the Advancement of Science, The American Physical Society and the American Chemical Society, New York, December 27, 1916.

We have shown, by experiments at Harvard, that this equation is not, in general, true, but that it does hold for particular cases. Mr. Hunt and I investigated the general X-radiation from a Coolidge tube, excited by a high potential constant voltage storage battery, using an X-ray spectrometer, and found that although the effective, or average, frequency does not obey the law represented in the equation (1), the equation does give the maximum frequency obtainable with a given electron energy. Dr. Webster then examined the characteristic X-radiation, and discovered that the kinetic energy of the electrons required to produce the alpha and beta lines of the K series is larger than is represented by equation (1), but that the gamma line (the highest frequency line in this series) approximately obeys the law. It appears, therefore, from our experiments, that equation (1) gives the maximum frequency of the radiation due to an electron's hitting an atom, but does not, in general, mean that the entire amount of the electron's energy is radiated at frequency ν.

I have recently shown that it is not necessary to assume that energy is radiated in quanta "h" in order to deduce equations for the distribution of energy in emission spectra similar to the equations representing black body radiation, so that we are not compelled to believe that because Planck's radiation law fits the facts of black body radiation more or less closely, therefore energy must be radiated in quanta $h\nu$. In attempting to explain why this constant "h" enters into the radiation law and in seeking for a physical conception of the mechanism of radiation, we are not therefore compelled to explain the emission of radiation in quanta $h\nu$, but rather the fact that an electron with a given kinetic energy, when it hits an atom, can produce radiations of frequency up to but not greater than that given by equation (1). This is the fundamental fact that needs explanation.

According to the modern conception of the constitution of matter, an atom possesses a complicated electro-magnetic structure in which the electrons play an important rôle. The electro-magnetic forces in this structure are greater near its center than at the periphery, and therefore the high frequency vibrations of the electrons must be associated with parts of the atom near its center. Hence, the reason why an electron can not produce a high frequency radiation unless it possesses a certain kinetic energy lies in the fact that it does not penetrate far into the atom unless it has a sufficient speed This presupposes a force of repulsion between the electron and the atom. The theory of atomic structure seems to demand such a force in order to explain why atoms do not collapse; so that we have confirmation of the existence of such forces from two sides: the radiation and the structure of matter.

Before discussing further the nature of this force and the laws it must obey, I would like to present to you a conception of the difference between line spectra and the general, or continuous spectra. The frequencies of the characteristic lines depend upon the nature of the atoms struck by the electrons, whereas the frequencies of the general radiation depend upon the kinetic energy of the electron that does the striking. This suggests that the characteristic lines are due to vibrations of parts of the atoms themselves (of electrons in the atoms, for instance) whereas the general radiation or continuous spectrum is due to the vibrations of the electrons that hit the atoms.

The question now arises "How can an electron vibrate with all possible frequency so as to give a continuous spectrum?" The electron moves in the strong electromagnetic field of the atom, and when an electron moves in a strong magnetic field, it follows a spiral path around a line of force. This motion in a spiral path radiates energy with a frequency that depends on the strength of the field, and is therefore variable. It is easily shown that in a case where the spiral is tightly wound around a line of magnetic force, the frequency is given by the equation

$$\nu = \frac{H}{2\pi}\frac{e}{m} \tag{2}$$

From this equation it appears that the frequency is independent of the velocity of the electron and of the radius of the spiral and that it is practically proportional to the strength of the magnetic field, and since H varies continuously, the frequency can have all possible values (up to a maximum), which gives the radiation the character of a continuous spectrum

Let us combine this conception of general X-radiation with the experimental fact that the maximum frequency due to the impact of an electron against an atom is given by equation (1). Suppose the electron to be traveling very nearly along the line of force coming from a very great distance, where its velocity is v and let x be its distance from any fixed point at the time t; let F be the total force acting on the electron in the direction of the weaker magnetic field. Then we can show easily that

$$F = \frac{h}{2\pi}\cdot\frac{e}{m}\cdot\frac{\partial H}{\partial x}. \tag{3}$$

We find, therefore, that a force of repulsion acting on the electron, the magnitude of which is represented by equation (3), will explain why an electron of given kinetic energy can not produce radiation higher than that given by equation (1).

A force such as that represented by equation (3) should hold an electron in equilibrium at a distance somewhat smaller than 10^{-8} from an atomic nucleus, if the nucleus had a charge e and the magnetic moment attributed to atoms and magnetons. Such a force would play an important rôle in determining the size and compressibility of atoms, the conduction of heat and specific heats, and a great variety of phenomena.

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THE RELATIONS OF MAGNETISM TO MOLECULAR STRUCTURE

MAXWELL'S classical theory of electricity and magnetism contributes little to our knowledge of molecular structure. For the portion of it which deals with material substances is exhibited in terms of quantities for which the process of definition wipes out structural distinctions. It is only through molecular theories of magnetism that magnetic phenomena may be correlated with molecular structure.

Langevin's theory of magnetism appears to be the soundest attempt to formulate such a theory He hypothecates the existence in the molecules of every substance of groups of electronic orbits which by virtue of the peculiarities of the structure of the molecules may be so arranged that the resultant magnetic field due to the electronic orbits in a given molecule at points without the molecule may or may not vanish. In the former case the molecule is diamagnetic, in the latter magnetic.

The effect of the application of a magnetic field to a diamagnetic substance is to change the orbital velocity of any electron. This change is in the proper direction to account for the diamagnetic polarity of the substance. Langevin's theory leads to an expression for diamagnetic susceptibility which does not involve the temperature, in agreement with Curie's law for diamagnetism. Numerous exceptions to this law exist, but the exceptions may probably all be taken care of by a slight extension of Langevin's theory as proposed by Oxley.

One of Oxley's most interesting conclusions is that the mutual magnetic field of two diamagnetic molecules in intimate contact is of the order of 10^7 gausses.

Langevin's hypothesis, while probably the most satisfactory yet advanced, leaves us quite in the dark as to a mechanical explanation of the architecture of the molecule.

In paramagnetic and ferromagnetic substances in accordance with the views of Langevin the rôle played by the molecule is not as in diamagnetic substances independent of the molecule's orientation in space, and it is necessary to assume that the effect of an applied field is to rotate the electronic orbits so that the direction of the resultant external field of a molecule tends toward that of the applied field. But the theory tells us nothing of the mechanism which will account for this orientation. Resisting the orientation will be heat agitation and perhaps inter-atomic and molecular actions of other than magnetic type. In a paramagnetic gas the resistance to orientation is supposed to be entirely due to heat agitation. The theory for such a gas leads to an expression for the susceptibility which depends upon both the impressed field and the temperature, but for fields attainable in the laboratory the susceptibility varies inversely with the absolute temperature in accordance with Curie's law for paramagnetism.

With the aid of the assumption that as regards rotation the molecules of a paramagnetic liquid behave like those of a paramagnetic gas it is possible to extend the theory of the gas to include that of the liquid, and such an extension is probably reasonably safe for liquids not given to polymerization.

In Weiss's theory of ferromagnetism it is assumed that, so far as rotation is concerned, the molecules of a ferromagnetic substance behave like those of a paramagnetic gas, a somewhat questionable assumption in this case. The effect of neighboring molecules upon a given molecule is assumed to be that which would be produced by a very large localized magnetic field of the order of 10^7 gausses. The theory based on these assumptions succeeds to a remarkable extent in explaining many of the facts of ferromagnetism.

The large internal fields hypothecated by Weiss and by Oxley are to be regarded as devices for averaging out in a measure the complicated effects due to molecular structure.

Through experiment Weiss was led to belief in the existence of an elementary unit of magnetic moment which he called the magneton. This corresponds in electrical theory to the electron. In many instances the magnetic moment per molecule appears to be very nearly an integer number of magnetons. But the evidence is not weighty enough to justify the acceptance unreservedly of this proposed new physical unit.

The subject of magneto-chemistry is already a very extended one. Here the attempt is made to establish a connection between the magnetic moment of a compound and those of its constituents, and additive relations are sometimes found. Substantial chemical information is often found through magnetic analysis. Various attempts have been made to explain chemical valency bonds through the magnetic attractions of rotating electrons in the atoms. One of these, that of Parsons, offers promise of considerable success in this direction.

The recent magnetic experiments of Barnett and of Einstein and deHass appear to prove definitely the existence of electrons rotating in closed orbits within the molecules of material substances, and thus furnish important support to Langevin's fundamental assumptions.

From this necessarily inadequate discussion you will infer that our molecular theories of magnetism are yet in a very unsatisfactory state in spite of the light which Langevin's ideas have thrown upon the subject, and that experiments upon the magnetic properties of bodies have not yet contributed in a very striking manner to our knowledge of molecular structure.

A. P. Wills

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ENROLLMENT IN SCIENCE IN THE HIGH SCHOOLS

In the issue of Science for February 12, 1915 (Vol. XLI., pp. 232–235), I called attention to the significance of the data given by the Commissioner of Education in regard to the enrollment in science studies in the high schools of the United States. The appearance of additional statistics for the five-year period 1910–1914 in the 1916 Report makes it possible to review the situation in the light of the new figures.

The table on page 489 of the Report of the Commissioner of Education for 1916, Vol. II., gives a summary of the enrollment in various subjects of the high-school curriculum in 1910 and 1915, both in terms of the numbers enrolled and in the percentage of the total enrollment. It is rather startling to find that in this five-year period there has been a drop of 44 per cent. in the enrollment in botany, stated in terms of the per cent. of the total enrollment, and one of 51.3 per cent. in zoology. The decline in botany has been from 16.34 per cent. to 7.19 per cent. and in zoology from 7.88 per cent. to 4.04 per cent. Physics has nearly held its own, changing from 14.79 per cent. to 14.28 per cent. while chemistry has made a slight gain, from 7.13 per cent. to 7.63 per cent. The other old-line sciences have all dropped off, physiology and physical geography quite heavily. Nor is the gain in the newer sciences enough to counterbalance the loss in the old. The percentage enrollment in agriculture has increased from 4.55 per cent. to 6.92 per cent., in domestic science from 4.14 per cent. to 12.69 per cent. The total percentage enrolled in science in 1909–1910 was 91.99 per cent., in 1914–1915 86.16 per cent., a drop of 5.83 per cent.

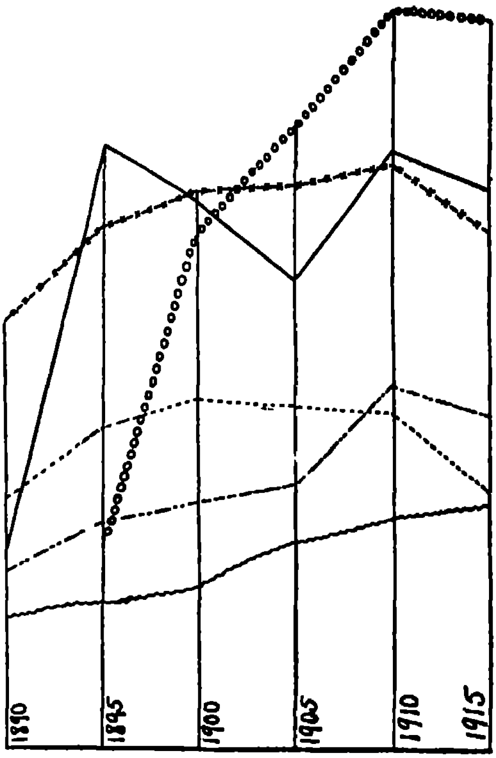

Fig. 1. Showing percentage of total enrollment in the high schools of the United States pursuing certain groups of studies, as follows: Classics, - - - - -; English, oooooo; History — — —. .; Mathematics, -x-x-x-; Modern Language ～～～～; Science, ————. 1 mm. = 1.2 per cent.

It seems strange that in an age when applied science is increasingly evident on every hand in the commonplace appliances of home, farm, factory and office that there should be any decline in the relative interest in science in the high schools. It is fairly evident that the high-school science course is in some way out of joint with the times. This decline in the science enrollment is not so alarming, however, when compared with changes in the other groups of subjects. The modern language group is the only one of the traditional subjects that shows an increase, that a small one of 1.5 per cent. The classics drop 11.04

per cent., mathematics 10.37 per cent., history 4.23 per cent., English 1.96 per cent. These changes are graphically presented in Fig. 1 and at the same time compared with the changes of the two preceding decades.

In general the interpretation put upon the data in the previous article seems still to maintain, namely (1) that the decline in the percentage of students in the old-line subjects is largely due to the introduction of many new subjects like manual training, domestic science, biology, agriculture, drawing, etc., most of which appear in the tabulation for the first time in the 1916 Report; and (2) that the science group is holding its own reasonably well. This is especially true of physics and chemistry which are usually offered in the third and fourth years of the course. Since the high-school enrollment is increasing very rapidly, 45.1 per cent. 1909–1914, while the percentage of pupils in the upper grades increases slowly (.49 per cent. for the third grade, 1.8 per cent. for fourth grade in the same five years), there is an increasingly large number of students that get no chance at physics and chemistry.

The data given for botany and zoology are indicative that another decade will see these biological subjects eliminated from the high-school curriculum. I am not sure that such a conclusion is justified, however; they may merely appear under a new caption. The data given for the whole United States may obscure what is going on locally and progress is usually local at first. Changes of opposite character may quite effectually obliterate each other when the data are massed. Thus the interest in French is largely concentrated in the New England States. More than 43 per cent. of the high-school pupils of Maine and New Hampshire are enrolled in French. The average for the New England States is 37.7 per cent.; for the North Central States, 8.07 per cent. The percentage enrollment in French has declined, though the enrollment in the modern languages has increased, largely due to the increase in Spanish in the Western States, the percentage of enrollment in it being 10.45 per cent. there, as compared with 0.76 per cent. in the North Central States.

The largest decline in botany and zoology has been in the North Atlantic States, where the percentage of enrollment has dropped in the five-year period from 16.28 per cent. to 6.46 per cent. in the former subject and in the latter from 9.64 per cent. to 3.18 per cent. But simultaneously the enrollment in biology has risen from 2.35 per cent. to 14.38 per cent. The percentage of enrollment in botany has changed in the North Central States from 17.72 per cent. to 12.79 per cent. and in zoology from 5.57 per cent. to 3.49 per cent.; but at the same time the enrollment in biology has risen from 0.13 per cent. to 1.64 per cent. and in agriculture from 4.97 per cent. to 9.78 per cent.

Botany and zoology are apparently giving way to related subjects that either appeal to school authorities as more effective educationally or to the public as more closely allied to everyday affairs. In view of the fact, now generally recognized, that knowledge and principles gained in one field of study do not carry over even into an adjacent field readily, it must be considered good policy in science instruction to deal with subject matter that is as nearly identical as possible with that which pupils will handle in their major life interests.

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SCIENTIFIC EVENTS

PROFESSOR ROBERTSON'S GIFT TO THE UNIVERSITY OF CALIFORNIA

Dr. T. Brailsford Robertson, professor of biochemistry and pharmacology in the University of California, has executed a deed donating to the University of California all his patent rights in the growth-controlling substance, "Tethelin," which he has succeeded in isolating from the anterior lobe of the pituitary body, and which has been employed to accelerate repair in slowly healing wounds. All profits resulting from this discovery are to constitute an endowment, the income to be applied to medical research.

Tests of this new chemical substance made in army hospitals in Europe and in civil hospitals in America have shown that it is of value in curing wounds and in causing wounds to heal promptly which for months or even years had refused to yield to treatment. While several new substances and new methods found by medical investigators since the war began have proved extremely useful in combating infections in wounds, "Tethelin" has a field of usefulness all its own—after other methods have rendered the tissues aseptic and wounds sometimes refuse to heal, especially where frostbite, burns, or varicose veins have injured the vitality of the tissues. There are thousands of such cases in Europe to-day and they occupy the hospitals for an exceptionally long time, consuming drugs, time, space, and food, and frequently such cases have to be discharged unhealed. It is precisely these cases—the most expensive and most disabling type of wounds—which "Tethelin" aids, since it stimulates the sluggish tissues and enables nature to work its own repair.

Professor Robertson has relinquished all personal profit from his discovery of this growth-promoting substance. In the agreement by which the regents of the University of California have accepted the trusteeship of this endowment for medical research it is provided that in case Professor Robertson should become physically disabled his present university salary would be continued throughout his lifetime, from the proceeds of the trust, or in case of his death, to his wife for her life time. All income above this contingent charge will go to endow an institute of medical research, devoted to research in medicine, and especially to research in the physiology, chemistry and pathology of growth.

Under the supervisory control of the regents of the university, the researches thus provided for are to be directed by a board of directors, of which the charter members are to be five members of the faculty of the University of California: Dr. F. P. Gay, professor of pathology; Dr. Herbert M. Evans, professor of anatomy; Dr. George H. Whipple, professor of research medicine and director of the George Williams Hooper Foundation for Medical Research; Dr. C. L. A. Schmitt, research assistant in pathology; and Professor Robertson himself. Vacancies on this board must be filled from men engaged directly and primarily in research work of the character mentioned or of some kindred character. No man who ceases to be so engaged may continue to serve as a director, and no director is to contine in service on the board after he arrives at the age of sixty. It is felt by the University of California that one especial value of the establishment of this foundation is the pattern which it sets for a procedure by which other scientific discoverers may dedicate the results of their scientific discoveries to the benefit of mankind as a whole.

THE HEALTH OF MUNITION WORKERS IN ENGLAND

THE report to the British government Committee on the Health of Munition Workers is summarized in the *Journal* of the American Medical Association. Dr. H. M. Vernon has conducted an elaborate investigation for the committee, the members of which realize that the data at their disposal are not yet ample enough to permit them to express a final judgment on the whole question of hours of labor in relation to output, on the one hand, and the well-being of the employees, on the other. But they are strongly of opinion that the evidence collected by Dr. Vernon and his conclusions merit the immediate and earnest consideration of all concerned in industrial organization at the present time (*a*) Observations extending over a period of thirteen and one half months on the output of workers employed in making fuses showed that a reduction of working hours was associated with an increase of production both relative and absolute. The rate of production changed gradually, and did not reach an equilibrium value before the expiration of four months. Thereafter it remained steady during the period of from three and one half to five months during which it was observed. The gradual change negatives the suggestion that the effect was a mere consequence of the desire to earn the same weekly wage as before the hours were shortened. (*b*) Owing to the reduction of the working time first by a change from a twelve-hour day to a ten-hour day, and subsequently by the abolition of Sunday labor, it was possible to compare output under three conditions. The group of women (numbering from eighty to one hundred) engaged in the moderately heavy labor of turning aluminum fuse bodies provided the following comparative results: (1) When actually working 66 hours a week and nominally 74.8 hours, their relative hourly production was 100 and their relative gross production 100. (2) When actually working 54.8 hours and nominally working from 58.5 to 66 hours, their hourly production was 134 and their gross production 111. (3) When actually working 45.6 hours and nominally working from 49.5 to 58.5 hours, their hourly production was 158 and their gross production 109. It is to be inferred, therefore, that had these women been working, uniformly, a nominal 50-hour week their gross output would have been as large as when they were working a nominal 66-hour week, and considerably greater than when they were working a 77-hour week. (*c*) A group of forty women engaged in the light labor of milling a screw thread on the fuse bodies improved their gross output by 2 per cent. when actually working 54.8 hours a week, the standard being their gross output when working 64.9 hours per week. A further reduction of actual working hours to 48.1 resulted in such an improvement of hourly output that the gross output was 1 per cent. less than when the actual working time was 16.8 hours more. (*d*) A group of fifty-six men engaged in the heavy labor of sizing the fuse bodies improved their hourly output by 37 per cent. and their gross output by 21 per cent. when actually working 51.2 hours, the standards being the hourly and gross outputs observed when the actual weekly hours were 58.2. (*e*) Fifteen youths engaged in the light labor of boring top caps by means of automatic machines produced only 3 per cent. less output when their actual weekly hours of work were 54.5 hours than when they were 72.5 hours. (*f*) A part of the improvement in output was due to the workers starting work more promptly when on shorter hours. At one period the women engaged in turning fuse bodies lost on the average thirty-seven minutes daily by starting work after, and stopping before, the nominal time. Nine months later, when their hourly output was 25 per cent. better, they lost only twenty-six and one half minutes daily in these ways. (*g*) A rest from work on Sunday is followed by a relatively low output on Monday, and this output steadily rises in the course of the week, owing to the increased efficiency produced by practise. Generally, the cumulative effects of fatigue neutralize and overpower this increased efficiency, and the output may fall after the second day (or night) of the working week if the hours are long and the work laborious, or not till after the third, fourth or even fifth day, if the hours are shorter. In the absence of a Sunday rest, the fatigued worker has no opportunity for complete recuperation and his output, though more uniform, remains permanently at a lower level than that shown on Monday by a worker who has rested on Sunday.

ELECTRICAL ENGINEERS AS LIEUTENANTS IN THE U. S. NAVAL RESERVE

1. THE Secretary of the Navy has authorized the commissioning of one hundred graduate electrical engineers as lieutenants, junior grade, in the Naval Reserve, and directed that the necessary action be taken to provide these officers at the earliest practicable date.

2. The qualifications for such officers to be in general as follows: (*a*) Citizens of the United States. (*b*) College graduates in electrical engineering. (*c*) Not less than three years' employment in electrical work since graduation. (*d*) Between twenty-five and thirty-five years of age. (*e*) Of character and physique required for officers of the regular service.

3. Pay and allowances of lieutenants, junior grade, are the same as in the regular Navy, and are, approximately: $2,200 at sea; on shore, including allowances for commutation of quarters, heat and light, $2,480. There is an

additional allowance of $150 for uniforms in time of war.

4. Eighty-five nominations of electrical engineers meeting the above requirements to be made by each of the following agencies:

(a) Naval Consulting Board.
(b) National Research Council.
(c) American Institute of Electrical Engineers.

5. Upon receipt of the 255 nominations thus made certain forms will be sent each nominee to execute, and upon receipt of the executed forms a Board of Naval Officers will select 100 for appointment.

6. After appointments have been made the officers so nominated and selected will be given a month's training and instructions on shore in naval methods, customs and regulations and instructions. Pay will begin on date of appointment.

7. Upon completion of the month's training on shore they will be ordered to the active fleet as electrical officers of ships for a period of at least six months. After this period they will be assigned to duty as the exigencies of the service may demand, excepting such as may be unfitted for the naval service.

8. The utmost care will be exercised in the nomination of these candidates as regards professional ability, physical condition, temperament and bearing, to the end that each one may qualify and not be subjected to inconvenience and disappointment and that the Navy may be benefited accordingly.

9. The Provost Marshal General of the U. S. Army has stated that any one subject to the Selective Draft Law may be released from compliance in order to accept an appointment as officer in the U. S. Naval Reserve Force.

10. Any one who now is in the Army, either volunteer or drafted, may make application but must obtain his discharge before he can be appointed. This includes any one who has been directed to appear before an exemption board. Those now in the Naval Reserve are eligible.

11. Individual nominations will be received, but any one making such should first assure himself that his nominee will agree to serve if selected and give as much information as possible to assist the committees in making nominations to the Department.

12. Any member of the electrical profession who can meet the technical requirements and who can submit proper credentials may make direct application to the undersigned.

13. To facilitate the work of selection, applicants should submit, in time to reach the committees not later than *October 15*, the following detailed information on the attached blank.

14. Letters from at least three responsible personal acquaintances should accompany each application.

15. From the nominations received the undersigned will each select 85 names to be forwarded to the Bureau of Navigation, Navy Department, Washington, D. C., from which total 100 names will be finally selected for commissions.

Applications may be sent to any one of the undersigned:

NAVAL CONSULTING BOARD OF THE U. S.,
13 Park Row, New York,
NATIONAL RESEARCH COUNCIL,
33 West 39th Street, New York,
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS,
33 West 39th Street, New York.

NEW YORK,
October 3, 1917

THE PSYCHOLOGICAL EXAMINATION OF RECRUITS

As was announced in SCIENCE at the time, a committee on psychology has been organized, with the approval of the council of the American Psychological Association, by the National Research Council. This committee consists of J. McKeen Cattell, G. Stanley Hall and E. L. Thorndike, from the National Academy of Sciences; Raymond Dodge, S. I. Franz and G. M. Whipple, from the American Psychological Association, and C. E. Seashore, J. B. Watson and R. M. Yerkes, from the American Association for the Advancement of Science. Dr. Yerkes, this year president of the American Psychological Association, lately professor of comparative psychology at

Harvard University and recently elected head of the department of psychology at the University of Minnesota, is chairman of the committee, and has been made a major in the Sanitary Corps of the Army in charge of the Section of Psychology, which has been established in the office of the Surgeon General.

A number of committees were organized and are now at work on different problems connected with the conduct of the war and national efficiency, partly under the auspices of the office of the Surgeon General and partly in the office of the Adjutant General. Information concerning the work of the committee on the psychological examination of recruits has been communicated to the press.

The members of that committee are R. M. Yerkes, W. V. Bingham, professor of psychology, Carnegie Institute of Technology, Pittsburgh; H. H. Goddard, director of research, the Training School, Vineland, N. J ; T. H. Haines, professor of medicine, Ohio State University; L. M. Terman, professor of educational psychology, Stanford University; F. L. Wells, psychopathologist, McLean Hospital, Waverley, Mass.; and G. M. Whipple, professor of educational psychology, University of Illinois. This committee met continuously for two weeks planning methods and tests. The seven men then separated, went to various parts of the country and applied the methods in actual practise. After making about 500 examinations they gathered again for two weeks and worked over the methods.

Six weeks after the first gathering of these psychologists, their test sheets, report blanks, etc., were ready for the printer. Arrangements were made for a trial of the method under working conditions with large numbers of men. About 4,000 men in regular organization camps, officers' training camps and naval stations, were examined, and special attention was given to correlating the ratings from the psychological examinations with the ratings prepared by the usual army methods.

The results of these thousands of examinations were sent to Columbia University, where, under the direction of Professor Thorndike and with the cooperation of Professor Cattell, Professor Woodworth and other members of the department of psychology, ten assistants and computers worked a month assembling and analyzing the statistical results. Again the seven psychologists went over their methods in the light of these 4,000 examinations to make further improvements.

The psychological examinations are now in progress in four of the national army cantonments: Camp Devens, at Ayer, Mass.; Camp Dix, at Wrightstown, N. J.; Camp Lee, at Petersburg, Va.; and Camp Taylor, at Louisville, Ky. There are about 160,000 men to be examined in these cantonments, and each will receive an intelligence rating as a result of the psychological examination.

The work is undertaken, first, to supplement the medical examination and second, to give line officers estimates of the mental ability and special aptitudes of their men. Reports of the psychological examinations will be made to the chief surgeon of the camp or the psychiatric officer in order that those mentally incompetent may be considered for discharge, and to the regimental and company officers in order that they may use this additional information concerning their men for the improvement of the service.

SCIENTIFIC NOTES AND NEWS

Dr. Otto Klotz has been appointed chief astronomer and director of the Dominion Astronomical Observatory at Ottawa.

Dr. Salvador Debenedetti has been appointed to the directorship of the Museo Etnografico at Buenos Aires, in place of the recently deceased Dr. Juan B. Ambrosetti.

Clarence Ebaugh, professor of chemistry in Denison University, is on leave of absence for the year 1917–18, to serve as chairman of the Council of National Defense for the state of Utah.

Dr. John Preston, superintendent of the State Insane Hospital, Austin, has been appointed by the Medico-Psychological Society to organize neuropsychiatric hospital units to be attached to the base hospitals and other military sanitary units. Dr. Preston has appointed the following committee to carry out these plans: Drs. Marvin L. Graves, Galveston; John S. Turner, Dallas; George F. Powell, Terrell; Thomas B. Bass, Abilene; James R. Nichols, Austin, and John W. Bradfield, Austin.

DR. G. BACHMANN, professor of physiology in the Emory University School of Medicine, has been appointed cardio-vascular examiner with the rank of first lieutenant and has been assigned to duty at Camp Gordon, Atlanta, Ga.

MAJOR CHARLES F. HOOVER, professor of medicine, Western Reserve University and assistant director of Lakeside Base Hospital in France, is now in Cleveland on leave of absence.

DR. RESTON STEVENSON, assistant professor in charge of physical chemistry in the College of the City of New York, has been appointed captain of the Sanitary Corps of the United States Army.

SEVERAL members of the faculty of the Pennsylvania State College are on leave of absence for national work. Professor E. D. Walker, head of the department of civil engineering, is captain in Company A, of the 5th regiment of Engineers, which left Pittsburgh about July 8 for foreign service. Professor Hugo Diemer, head of the department of industrial engineering, has received a commission as major in the Ordnance Department. He is at present located at Lowell, Mass., in charge of the inspection of fire arms. Other members of the faculty who are in military service are Mr. J. J. Light, of the department of mechanical engineering, who has been commissioned a captain; Lieutenants Steel, Long and Bryans, of the department of civil engineering, are on duty at various camps; Mr. Mills, of the electrical engineering department, is in Washington on naval construction.

OF the members of the instructing staff of the department of chemistry at the Massachusetts Institute of Technology, Professors W. H. Walker and J. F. Norris, Dr. F. H. Smyth and Mr. R. E. Wilson are on leave of absence, and Professor W. K. Lewis devotes only part of his time to the institute during the present year. All these men are actively engaged on gas-defense problems, and are holding responsible positions in the organization which is dealing with these problems at Washington and elsewhere. Professor A. A. Noyes spends a part of his time at Washington, in connection with the work of the National Research Council and the Nitrate Committee. Professors Mulliken, Spear and Mueller have also been engaged at the institute on investigations relating to gas-defence. Professors F. J. Moore and H. P. Talbot gave, during a portion of the summer, courses of instruction to students who were expecting to apply for commissions in the Reserve Officers Training Corps.

AMONG the appointments recently made in the state department of education and registration by the governor of Illinois are those of Professor Thomas C. Chamberlin, head of the department of geology at the University of Chicago, and Professor John Merle Coulter, head of the department of botany at the same institution, to the Board of Natural Resources and Conservation. Professor Chamberlin is commissioner of the Illinois Geological Survey and has been president of the Illinois Academy of Sciences. Professor Coulter is now the president of the Chicago Academy of Sciences and has been for many years a special agent in botany for the United States Department of Agriculture. The Board of Natural Resources and Conservation is part of the state department of education and registration, at the head of which is Francis Wayland Shepardson, formerly associate professor of American history at the University of Chicago.

FRANK CARNEY, Ph.D., professor of geology and geography at Denison University, has resigned to enter the employ of The National Refining Company of Cleveland, Ohio.

PROFESSOR H. F. CLELLAND, secretary of the New England Intercollegiate Geological Excursion, announces that the excursion will be taken on Friday and Saturday, October 12 and 13, and will be in charge of Professor J. B. Woodworth, of Harvard University, and Dr. Edward

Wigglesworth, of the Boston Society of Natural History. It is planned to visit the cliffs of Weyquobsque, Nashaquitsa, and Gay Head, on the island of Martha's Vineyard. Information can be obtained from Professor Woodworth at the Geological Museum, Oxford St., Cambridge, Mass. Circulars will be sent to all persons on the secretary's list.

At Harvard University, a plan for an investigation of the stratigraphy of the Ordovician formations of the Appalachians has been approved by the committee on the Shaler Memorial Fund. Three seasons, under the supervision of Professor Percy E. Raymond, have been arranged. During the past summer, work has been carried on in Vermont, Pennsylvania and Virginia by Dr. Raymond, in collaboration with Mr. Richard M. Field, lecturer at Brown University, Professor E. W. Shuler, of Southern Methodist University, and Professor S. L. Powell, of Roanoke College.

The National Geographic Society's expedition to Mount Katmai, which sailed for the north on May 28, reached Seattle on September 30. The head of the expedition is Dr. Robert F. Griggs, of the Ohio State University.

The Elisha Mitchell Scientific Society held its business meeting September 20. The following officers were elected: Mr. J. G. Beard, president; Dr. J. M. Bell, vice-president; Mr. W. W. Rankin, recording secretary. The following board of editors was elected for the *Elisha Mitchell Journal:* Dr. W. C. Coker, chairman, Mr. M. H. Stacy and Mr. Collier Cobb. The following were elected to membership in the society: Dr. A. W. Hobbs, Messrs. B. Markham, H. M. Sharpe and W. W. Kirk; to associate membership in the society: Messrs. J. O. Bynum, L. G. Marsh, G. B. Lay, W. W. Eagle, E. H. Griffin, W. F. Morrison, R. W. Parks, J. W. Sawyer, N. A. Reasoner, J. W. Smithey, O. H. Herty, Jr., R. H. Rimmer, B. L. Meredith, L V. Giles, and R. D. Ballew.

The California Academy of Sciences has provided a course of lectures on popular scientific subjects to be given at three o'clock each Sunday afternoon in the auditorium of the Academy's Museum in Golden Gate Park, as follows:

September 23. Professor S. J. Holmes, department of zoology, University of California, "Social evolution and eugenic progress."

September 30. Professor C. A. Kofoid, department of zoology, University of California, "A visit to Easter Island," illustrated by stereopticon.

October 7. Dr Barton W. Evermann, director, California Academy of Sciences, "Birds of Pyramid Lake," illustrated by moving pictures.

October 14. Dr. Chester Stock, department of paleontology, University of California, "Pleistocene caves of California."

October 21. Dr. H. W. Fairbanks, supervisor of geography, Berkeley Schools, "Influence of climate and topography upon California's development."

Dr. Charles Hughes Johnston, professor of education in the University of Illinois and editor of *Educational Administration and Supervision,* was killed in an automobile accident near Elkridge, Md., on September 3, aged forty years.

The department of zoology of Smith College has been presented by the Boston Society of Natural History, through its curator, Dr. W. C. Johnson, with a complete collection of the land and freshwater mollusks of Massachusetts. This collection—every specimen of which is accurately determined and labelled by Dr. Johnson, will serve as a standard of comparison for any one wishing to identify the local molluscan fauna.

The *Indian Forester,* as quoted in *Nature,* describes the organization of the Chinese Forest Service, which came into existence in January, 1916, as a subordinate branch of the Ministry of Agriculture and Commerce at Peking. The heads of the service, styled "co-directors," are Mr. Forsythe Sherfesee, for six years employed in, and lately director of, the Philippine Forestry Bureau, and Mr. Ngan Han, who studied forestry in Cornell and Michigan universities several years ago. There are other Chinese in the service, who have received a technical training in the United States, and an expert from Kew, Mr. W. Purdom acts as botanist and is chief of one of the six divisions into which the service is organised. In this article an ambitious program of afforestation, education, propaganda, etc., is sketched out, but no details are given of any work that has been actually accomplished.

IN connection with the search for potash and nitrates in the United States the government receives many reports of supposedly valuable discoveries. A letter recently received by the United States Geological Survey of the Interior Department describes a cave in one of the Southern States which was worked by the Confederacy during the Civil War for potassium nitrate. This cave is said to contain at least 1,000,000 tons of nitrous earth, which, however, contains only 1 to 2 per cent. of nitrate. The survey now states that it seems very doubtful whether such material can be profitably used as a source of nitrate salts. The minimum grade of caliche now worked in the Chilean fields contains 12 per cent. of sodium nitrate, and though there has been much criticism of the crudeness of the methods employed there, the work is done by very cheap Indian labor, and it is doubtful whether leaner material could be worked to advantage here, where the price of labor is so much higher. Several hundred thousand dollars have recently been expended in one of the Western States in testing the proposition to utilize low-grade nitrate. The results have been negative. The nitrate caves in the South were worked during the Civil War by very crude methods. Generally the cave earth was shoveled into iron pots, where it was treated with water and heated over wood fires to leach out its soluble parts. The liquor was drawn from one pot into another and used for treating fresh material until it became a highly concentrated solution of nitrate salts. It was then drawn off and allowed to cool, whereupon the nitrate crystallized. The remaining liquor was then employed to leach fresh material and the crystals were separated and sacked for use.

To make the desert regions of the western part of the United States more accessible by locating their widely separated watering places and erecting hundreds of signposts to give directions and distances to the watering places is an interesting and practical project recently undertaken by the United States Geological Survey, Department of the Interior. The project involves also the work of making accurate maps showing the locations of the watering places, of preparing guides describing them and giving the distances between them, of selecting well sites, and of developing watering places (so far as money available will permit) in localities where water is most needed and where the geologic investigations indicate that underground supplies can be obtained. It is expected that this work will help to expedite the discovery and development of the rich mineral deposits in parts of these regions. It will, of course, also be valuable in other respects. In recent years the water-supply geologists of the Geological Survey have developed trustworthy methods of locating ground water in arid regions from surface indications and of estimating the depth to water and the approximate annual yield of the underground reservoirs. These methods will be applied and further developed in connection with the survey of desert watering places. A number of Survey parties are now being organized in Washington and will in a few weeks be at work in the most arid parts of Arizona, California, and Nevada. Each party will consist of a geologist and one or more assistants and will be provided with an automobile and camping outfit.

UNIVERSITY AND EDUCATIONAL NEWS

THE will of Miss Kate Collins Brown, formerly of New Orleans, who died on August 19, disposes of an estate of more than $700,000 of which she left nearly $500,000 in direct bequests and gave the residue to Columbia and New York Universities and the Presbyterian Hospital. The share of the educational institutions is to establish scholarships paying $300 a year to needy students.

THE Pacific Coast Gas Association has given $4,415 to the University of California to further instruction and research in gas engineering.

THE nineteenth annual conference of the Association of American Universities will hold its annual meeting at the State University of Iowa on November 8, 9 and 10.

The Rev. Dr. Anson Phelps Stokes, secretary of Yale University, has been chosen principal of Hampton Normal Institute, to succeed the late Dr. V. B. Frissell.

Dr. William B. Meldrum, of Vassar College, has been appointed assistant professor of chemistry at Haverford College, taking the place of Lyman B. Hall, professor of chemistry, who resigned at the retiring age after thirty-seven years of service.

The following changes have been made during the summer in the staff of the department of geology at the University of Illinois: Professor C. W. Rolfe has retired as professor emeritus. Mr. Fred H. Kay, lecturer on petroleum geology, has gone into the service of the Sun Oil Company; Dr. F. M Van Tuyl, instructor, has resigned to accept the assistant professorship of geology in the Colorado School of Mines; Dr. C. W. Tomlinson, A.M. (Wisconsin), Ph.D (Chicago), has been appointed associate in structural and general geology.

Mr. F. A. C. Perrine has resigned as assistant professor of psychology at the University of Pittsburgh to accept the position of adjunct professor of psychology at the University of Texas. Mr. Jos. U. Yarbrough was made an instructor in psychology at the University of Texas.

Dr. J. W. Beede, associate professor of geology at the Indiana University, has accepted a position in the bureau of economic geology and technology, in the University of Texas.

At Cornell University, Bernard A. Chandler has been appointed assistant professor of forest utilization for 1917–18, in place of Professor A. B. Recknagel, who is absent on leave.

DISCUSSION AND CORRESPONDENCE

INTERNATIONAL UNITS AND SYMBOLS IN AEROGRAPHY

To the Editor of Science: In the somewhat appreciative review of the text-book on "Aerography" in Science, September 14, 1917, on p. 265 is the statement "the student may be confused in having absolute pressure units presented as 'kilobars' when they are commonly known as 'millibars.'" The reviewer underestimates the intelligence of university men; because the reasons why kilobar is preferable are given at length on page 30. Kilobar is as natural as kilogram. It may also be added that those who persist in advocating the retention of millibar are evidently not aware that V. Bjerknes expressly states that in his system the C.G.S. unit will be the *microbar.*

Again, the statement of the reviewer that "kilobar has historic preference over millibar but millibar is the internationally accepted term" is both inaccurate and misleading. Millibar is the earlier term and it has international acceptance only because there has been no opportunity to have the mistake corrected by international agreement. Moreover it is extremely problematical if the International Congress will ever meet again. But is it good form in scientific work to continue the use of an erroneous term because an official disclaimer is lacking? There are some other matters which are of perhaps greater moment. It is a strange commentary upon the work of the International Meteorological Congress that while giving us symbols for no less than 23 conditions varying from haze to aurora, there are no symbols for bright and diffused sunshine, mountain and valley winds, temperature inversion and sea-breeze. For the last named, the sea-breeze, we have been using at Blue Hill, three arrows on a vertical staff, to represent the characteristic changes in circulation. As the sea-breeze is a frequent and very important aerographic condition, any suggestion for a more fitting symbol will be appreciated.

Alexander McAdie

Blue Hill Observatory,
Readville, Mass.

SYMBOLS

I am confident that there is not a worker in the wide domain of physical science who has not wished for a standard series of symbols. The question is not a new one; it was considered by a committee of the American Association for the Advancement of Science many years ago, but its efforts were shattered in the attempt at international cooperation. Such cooperation is very desirable, but if it is not available that is no reason why America should deny herself the benefits of coordination which she, with her scientific resources, may devise. Every monograph, every textbook that is written adds to the confusion of symbols, for there are no standard tables to guide one. It seems to me not only possible, but practicable that a list of symbols could be compiled under various headings—mathematical, astronomical (with subdivisions), physical (with subdivisions), geophysical, electrical, etc. The various headings would be necessary because the same symbol is frequently used under different headings, and, of course, with different meaning. Whether we write *g* for terrestrial acceleration or *a* is fundamentally quite immaterial, so it is whether we write *L*, or ϕ, or λ for latitude, but it is not immaterial for the person who reads it. He will probably wonder why the writer doesn't use such and such symbol. We want uniformity, uniformity to as great an extent as possible. Personal preferences should be waived and sunk in the greater scheme of uniformity. There are already many constants, many expressions, many concepts that await being labeled for common recognition. Who is to undertake this work, who is to do the labeling? I can see, or rather I can hear rumbling—"I'm not going to be bound by any such tables." Quite so, they would have no authority whatever. However the dictates of common sense would be their propelling force and I think the vast majority of American scientific writers would avail themselves of their usefulness. Anything that promotes readiness of understanding and ease of reading mathematical expressions and equations should be encouraged.

In order to give definiteness to my ideas, which I hope will arouse discussion, I would suggest that the tables of symbols spoken of be prepared by the Carnegie Institution of Washington. It is work that so eminently falls within its scope, and it is so well equipped with material and other resources, that one can look forward with confidence to a well-matured publication. Should the work be undertaken by the Carnegie Institution nothing would further the general adoption of the symbols promulgated more than the wide distribution of the publication and that could be profitably effected by sending to every scientist—to every man in "American Men of Science"—gratis a copy of the Carnegie publication.

My closing word Don't let details smother uniformity. Make a start. OTTO KLOTZ

DOMINION OBSERVATORY,
OTTAWA,
August 4, 1917

BACTERIAL LEAF SPOT OF TOBACCO

A BACTERIAL leaf spot of tobacco has been found to occur within certain sections of North Carolina. This disease, because of the rapidity with which it spreads, has appropriately been given the name "wild fire." It first manifests itself in seriously destructive form at the time of transplanting, so that in some fields it has been necessary to replace the seedlings by a second and a third transplanting. Plants in the seed beds from which these seedlings were taken have been found to be diseased, indicating that the malady was introduced from the seed beds.

The disease first appears as circular yellow spots about 1 cm. in diameter. A minute brown area indicates the center of the spot. Within a few days the brown area will have enlarged to 2 or 3 cm. in diameter with a translucent border and surrounded by a wide chlorotic halo. When the spots are numerous they fuse, forming large brown irregular areas which in severe cases involve most of the leaf tissues.

Isolation and inoculation work has shown that the disease is due to a grayish white bacterial organism which is heretofore undescribed. This organism is rod shaped, about three times as long as wide, and actively motile by a single polar flagellum. It is therefore referable to Cohn's Bacterium as amended by Smith and is given the name *Bacterium tabacum*. The detailed account of the cultural studies and inoculation experiments which have been made, and of the distribution and dissemination studies which are in progress, is reserved for subsequent publication.

F. A. Wolf,
A. C. Foster

North Carolina Experiment Station

PLANT DISEASES IN CANADA

To the Editor of Science: Two plant diseases have recently been observed in the Dominion of Canada which have not been recorded before, viz., *Dothichiza Populea* Sacc. et Briard, on Lombardy poplar, St. Andrews, N. B., and *Colletotrichum cereale* Manns, on spring wheat, Charlottetown, P. E. I.

A third disease affecting seed pods of turnips grown for seed in P. E. I. caused by *Leptosphaeria Napi* (Fuckel.) Sacc., of which the conidial form *Sporidesmium exitiosum* was found, does not appear to have been recorded as causing trouble on the continent of America. It is well known in Europe, where it is disastrous to seed turnip cultures.

H. T. Güssow

COMMON PLANT NAMES

To the Editor of Science: May I draw attention to a point in the discussion on popular names of plants, which M. A. Bigelow, in Science of July 6, seems to ignore; that is, the great literary value of a good common name and the danger that such names may be lost through being ignored by teachers. Of course children can learn any name—they memorize far more easily than grown people—but do not let us give them scientific names to learn as a part of nature study, unless they are going in for botany as a science. Scientific names are usually clumsy and pedantic, almost always lacking in character, and often can not be gracefully absorbed into the English language.

The names which Professor Bigelow cites as being both popular and scientific are sufficiently euphonious, but are almost all those of garden plants, which may be allowed to bear florists' names. The few wild flowers he mentions all have good common names, which apparently he is willing to discard. Primrose is an older name than *Primula,* I fancy, and for the matter of that, surely rose, lily and violet antedate the systematists! *Clematis* and *Trillium* are pretty enough, but virgin's bower and wake-robin are names to make a poet sing for joy. Most eastern wild flowers have fairly good names and even in the west—a young civilization is apt to be content with variations of "bells" and "roses"—they have some fine names, such as "our Lord's candle" (*Yucca Whipplei*), "sweet-after-death" (*Achlys triphylla*) and "flaming sword" (*Fouquiera splendens*). Such names as these enrich our language and should be preserved at all costs.

Shall we encourage children to gather nosegays of *Blepharipappus, Mesembryanthemum* and *Malacothrix?* Heaven forbid! Only give them time and children will evolve good names for all conspicuous wild flowers, if we do not thwart them by teaching the scientific ones unnecessarily. Cat's breeches, named by Utah children, may not be elegant, but it is quaintly appropriate and is certainly better for everyday use than *Hydrophyllum capitatum.* Let us go slowly in these matters and so long as men like Dr. Jepson are continually on the lookout for good common names we need not despair.

Margaret Armstrong

A SIMPLE EXPLANATION

In Science, August 31, 1917, page 212, Professor C. A. Mooers writes as follows:

> The writer has assumed that Dr. Hopkins could give a simple explanation for his conflicting estimates, as given in Science, November 3, 1916, p. 652, and in Science, March 2, 1917, p. 214. In the former article he says: "For each dollar invested rock phosphate paid back \$2.29," but in the latter article he says, with regard to the same data, "Easy computations show profits per dollar invested of . . . \$1.29 from phosphate rock."

The "simple explanation" is that these are not conflicting statements. Each dollar invested in raw rock phosphate paid back $2.29; and, when the dollar invested is subtracted from this amount, the profit is found to be $1.29.

In this article Professor Mooers bases his opinions in part upon "observations" and "hay data . . . not given in Bulletin 90," states that in his conclusions he "was governed chiefly by a consideration of the soil conditions and the results of the individual series"; and he criticizes my use of a summary table which he prepared and which he also used in his bulletin[1] and in his former Science article.[2] His present opinion is that this summary table is not fairly representative of the results secured, and I must bear his criticism for having used it.

Cyril G. Hopkins

University of Illinois

QUOTATIONS

COLUMBIA UNIVERSITY AND PROFESSOR CATTELL

It is contrary to the academic traditions of six hundred years to dismiss a university professor on account of his opinions expressed in a proper way to experts in the subject. It is illegal to dismiss a professor in the middle of the academic year on false and libelous charges, without payment for the year and without the pension which he had earned by twenty-six years of service.

I am opposed to war and to this war, but I have undertaken no agitation against the government nor against its conduct of the war. I have written nothing against the draft law or against sending armies to Europe, although I regard both measures as subversive of the national welfare.

It is because I care for my country that I deplore its entry into a war of aggression and the government's policy of strangling democratic principles at home. For the same reason I have in the journals which I edit done what I could to promote national efficiency. I am a member of the Psychology Committee of the National Research Council and spent a large part of last week drawing up for the War Department plans for the scientific selection of aviators.

In August, 1914, when President Wilson was telling us to be neutral in thought as well as in speech and in act, and Mr. Roosevelt and Dr. Nicholas Murray Butler were "pussyfooting," I wrote in one of the journals that I edit:

> The official German justification of the mad and wanton European war is that it is in defense of the Teutonic culture and people against the semi-Asiatic and barbaric Slav hordes. The verdict of history will probably be that it was a war of calculation for caste and national aggrandizement, and a war of miscalculation. The German emperor and his bureaucratic military entourage probably held that the time was ripe for an extension of German influence in the Balkans and towards Asia Minor with an increase of its African possessions at the expense of France But it is not clear why, if the serpent was prepared to use its fangs, it did not show its alleged wisdom. . . . We may look for a second Napoleon the little rather than for a second Napoleon the great.

In June, 1917, I began a letter to the New York *Evening Post* with the words:

> An emperor, driven by the militaristic and capitalistic classes of his people and "by God demented," must accept responsibility for the great crime.

The letter that I wrote on August 23 to members of the Congress, on account of which I have been dismissed from the chair of psychology at Columbia University, asked support for a measure then before the Senate and the House to prohibit sending conscripts "to fight in Europe against their will." There is no law requiring or permitting the President to send "conscientious objectors" to fight in Europe. To do this would be contrary to the intent of the constitution and to the uniform policy of the nation. It would provide a less efficient army and might cause disorder and possible revolution at home. Surely this should not be done without careful consideration by the Congress after efforts to learn the will of the people. I have only exercised the constitutional right and fulfilled the duty of a citizen in petitioning the government to enact legislation which I believe to be in the interest of the nation. For this I am dismissed from the division of philosophy, psychology and anthropology, which I have made the strongest in the world. Professors in every university are terrorized, so that they dare not exert their influence for peace and good will.

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[1] Bulletin No. 90, Tennessee Agricultural Experiment Station.

[2] Science, January 5, 1917.

The people of all the European nations long for peace, but are kept at war by the kleptocratic classes. In spite of the institutions and the instincts which we have inherited from a barbarous past, I believe that our people have no heart for this war into which they have been driven. But even if the nation should become a mob mad for war, it is none the less the business of each of us to do what he can for righteousness as he sees it. If that is forbid by force, then indeed we need a new national anthem, such as Shelley once wrote for England:

God prosper, speed and save,
God raise from England's grave
Her murdered Queen!
Pave with swift victory
The steps of Liberty,
Whom Britons own to be
Immortal Queen.

—J. McKEEN CATTELL *in a statement printed in the daily press.*

SCIENTIFIC BOOKS

Chemistry in the Service of Man. By ALEXANDER FINDLAY, M.A., D.Sc., F.I.C. Longmans, Green & Co., London, New York. 1916. Pp. xiv + 255. Price $1.60.

This book is the outgrowth of a series of lectures—the Thomson Lectures—delivered by the author before the United Free Church College at Aberdeen, near the close of the year 1915. It represents the attempt to lay before a group of college men, who made no claim to chemical knowledge, some account of what chemistry has accomplished for the well-being and uplift of mankind, and also some glimpse of the relation of chemistry to the war. The book is in England especially timely, from the fact that among the educated classes, as well as among the business men and industrialists, an appreciation of chemistry has been sadly wanting. The case is somewhat different in this country, since for many years chemistry in a large share of our colleges and universities has been either a required study or a widely chosen elective, and has become a part of the curriculum of most of our high schools. Probably on account of this our manufacturers have shown far less reluctance than those of England to abandon their "rule of thumb" methods.

Such books as the one before us are always timely, never more so than to-day, provided the author is a master of his subject and at the same time capable of expressing his thought in language that can be understood by the man with little or no previous knowledge of chemistry. Dr. Findlay well fulfils both of these conditions. His work in physical chemistry is well known; his success in opening up difficult fields in chemistry to the comprehension of the ordinary chemist is evidenced by the clearness of his "Phase rule and its applications" and his "Physical chemistry and its applications in medical and biological science." This latter book, by the way, should be read by every medical student.

The aim of "Chemistry in the service of man" is best set forth in a sentence in the introductory lecture: "In attempting a brief and necessarily incomplete survey of chemistry in the service of man, I shall endeavor not merely to recount some of the manifold ways in which chemistry has revolutionized life and has contributed, on the material side, to a civilized existence; but I shall try, also, to indicate, if I can not do more, some of the principles which underlie chemical change, and some part of the contribution which chemistry has made to our knowledge of the constitution of matter." The latter is rather an ambitious program for a *popular* book, intended for readers without previous knowledge of chemistry. The chapters entitled "Velocity of reaction and catalysis," "Electricity and chemistry," "The colloidal state," and "Molecular structure" would hardly seem fitted for *popular* perusal, and yet so clearly are the fundamental principles treated that any intelligent man, or high-school scholar, for that matter, would hardly fail to be understandingly interested in the application of these principles to important facts of every-day life. The consideration of catalysis leads to its application in the manufacture of sulfuric acid and the hardening of fats, and to some of the facts concerned with digestion; in connection with electricity are discussed the refining of metals, the manufacture of chlorin and caustic soda, and many electric-furnace products; the colloidal state is illustrated by photographic plates, the sedimentation of rivers, plasticity of clay, dyeing and water and sewage purification. Perhaps the most interesting chapter is that concerned with the fixation of nitrogen, particularly applicable to the demand, both for munitions and for fertilizers, at the present time. Other chapters are "Combustion, and the production of fire," "The chemistry of illuminants," "Energy, fuel and explosives," "Cellulose and cellulose products," "Glass, soda, soap," and "Synthetic chemistry." All are exceedingly readable, and are to be recommended, not only to the man who desires to get a glimpse of what modern chemistry is doing for the comfort and needs of life, but quite as well to the first-year student of chemistry, in school or in college, who has far too often come to regard the study as a mass of unconnected facts and abstruse theories, mingled with a mess of dirty test tubes and beakers. In this book one gains a glimpse of the beauty of it all, if indeed one has any comprehension of beauty.

One word remains to be said. Many of us were trained in our earlier years to believe that for the past half century all chemistry was "made in Germany," and in this there was far more of truth than of fiction. And yet it is hardly an exaggeration to say that in England, America and France more progress has been made in the past thirty-six months than had been made in Germany in the previous thirty-six years. Perhaps the same has been true of Germany; our information regarding this is meager. As never before, chemistry is "coming to her own," and hence the timeliness of Dr. Findlay's "Chemistry in the service of man"

Jas. Lewis Howe

Washington and Lee University

Ulugh Beg's Catalogue of Stars. By Edward Ball Knobel. Carnegie Institution of Washington, Publication No. 250. 1917. Pp. 109.

Mr. Knobel's compilation of Ulugh Beg's Catalogue forms a fitting sequel to Ptolemy's Catalogue of Stars, also edited by Mr. Knobel in conjunction with Dr. C. H. F. Peters. Ulugh Beg, born in 1394, succeeded his father as ruler of Persia in 1447. Two years later he was killed by his son. He devoted much of his time to astronomy, was the founder of an observatory at Samarkand, which is located in the southern part of Russian Turkestan, and in the year 1437 published a catalogue of stars.

Such catalogues furnish at best only rough determinations of stellar positions because of a number of causes. To add to the insecurity of the positions, it is not always certain whether all the stars of such a catalogue have been directly observed by the author, or whether, for the sake of completeness he has added star positions determined by predecessors, and reduced to the epoch of his own catalogue in a manner unrecorded. Added to this is the doubt whether the manuscripts available contain a true record of the original catalogue.

While it is eminently worth while to preserve such a catalogue, if only for historical purposes, great care should be taken not to place too great dependence upon its star positions.

Mr. Knobel has apparently made a thorough investigation of the subject. In addition to the catalogue proper he has included a comparison of Ulugh Beg's star positions with positions reduced from Piazzi's catalogue, with the exception of 300 stars whose positions were reduced from the catalogues of Danckwortt and Neugebauer. Following the comparisons he has collated the manuscripts which were examined, and closes the volume with a vocabulary of Persian words prepared by Dr. Peters which Mr. Knobel has subsequently revised and amended.

Benjamin Boss

Dudley Observatory,
Albany, N. Y.

FIVE YEARS OF STARVATION OF LARVÆ

The specimens concerned are the larvæ of *Trogoderma tarsale,* a small beetle well known as a museum pest. The last of a large number of specimens lived, without a particle to eat, for the suprisingly long period of five years, one month and twenty-nine days or, to be more specific, from October 28, 1911, to December 25, 1916, a period of 1,884 days. The case is decidedly outstanding, as to my knowledge, nothing similar has ever been recorded as a result of starvation experiments with other animals. It is very probable that under otherwise non-disturbing conditions the starving larvæ would have lived for even a longer period. The specimens concerned in this article had undergone considerable disturbance after the first two years of starvation, since many of the larvæ made the trip between Idaho and Wisconsin with me three or four times, and several of them covered the distance five times. The trips one way varied in duration from four to seven days. There is no doubt but that the jarring of the train had accelerated the metabolism of the larvæ. This fact was evinced by the moulting of practically every individual toward the end of the trip or within a few days after it, and by the decided decrease in the dimensions of the larvæ immediately following such a moult. Larvæ placed under starvation shortly after my arrival in Idaho in the summer of 1913, which have not been so disturbed, show indications of even greater tenacity than is here recorded.

It will not be out of place here to mention how the starvation experiments with this particular species which proved to be of such unusual interest came about. While a graduate student at the University of Wisconsin the writer got into a dispute concerning the classification of the larvæ. To prove his point he decided to grow some of the specimens to maturity and thus obliterate the uncertainty of identification. A number of the largest larvæ available were placed in glass dishes together with some food material. Not having plenty of the favorite food material at hand at the time, several specimens were placed in other dishes without food and set aside in a separate drawer with the intention of providing for them later. However, these were neglected until the opening of school the following September when the writer accidently discovered them in their secluded place. Much to his surprise all of the specimens were alive, in spite of the fact that they had remained there for five months without a thing to eat. It was also noticed that the larvæ had decreased in size. This observation was further substantiated by the gradual decrease in size of the various cast-off skins, which this species is not known to attack. This interesting information later led to experimental work on the longevity of the larvæ, without food, on a large scale.

A number of specimens varying in size from newly hatched to practically full-grown larvæ were placed in individual sterilized vials for the purpose of ascertaining the period of time that they could live without food. Even the newly hatched specimens showed an amazing tenacity by living over four months without ever having eaten at all. Some of the one fourth grown specimens lived for fourteen months; those about one half grown lived almost three years; those three fourths grown lived four years; and most of the largest specimens lived over four years, several of them over four and a half years, and one five years and seven days; while the last one died after five years, one month and twenty-nine days of starvation.

One of the most interesting phases of these experiments is the gradual decrease in size of the individual specimens. Many of the largest larvæ which were about 8 mm. in length dwindled down to practically the hatching length of 1 mm. before dying, and practically all of the specimens which were below 7 mm. at the beginning of the experiment dwindled down to the same dimensions. Many of the larvæ of 2 and 3 mm. were reduced to somewhat below the hatching length, and practically all of the newly hatched specimens fell down to about three fourths of their original length. Speaking in terms of reduction in size, it is astonishing to note that some of the largest larvæ have been reduced to about 1/600 of their maximum larval mass.

Another, and even more interesting phenomenon, is the fact that when the starved specimens almost reach the smallest size possible and are then given plenty of food, they will again begin growing in size. A number of the larvæ which were half grown when placed under starvation for the first time, have through alternating periods of "feasting and fasting" attained that size three times and are now on the way to their fourth "childhood"; and even some of the large specimens have started dwindling down to their third "childhood" after having twice attained the practically maximum larval size.

Occasionally these larvæ are found in large numbers in insect, seed and drug collections, and naturally destroyed as soon as discovered. The writer would appreciate any amount of this living material that the reader may happen to find if he has no use for it himself. The larvæ, pupæ or living adults of other dermestids are equally desirable for the purpose of comparative studies. In response to a recent circular letter many men have already sent me some valuable material. The names of the donators will appear in the forthcoming detailed publication of this extensive and of necessity prolonged investigation.

The problem has now attained enormous proportions and involves the use of thousands of specimens. Many normal larvæ of different sizes, as well as many specimens in the different periods of starvation have been sectioned during the past few years, and comparative cytological studies of the various structures of the organisms are being made. Physiological studies with special reference to metabolic water and excretion have also been started.

J. E. Wodsedalek

University of Idaho,
Moscow, Idaho

SPECIAL ARTICLES

THE RÔLE OF THE NUCLEUS IN OXIDATION[1]

In 1897 Spitzer[2] reported that nucleoproteins extracted from certain animal tissues have the same oxidizing power as the tissues themselves. The idea that the nucleus is a center of oxidation was advocated by Loeb,[3] who pointed out that this would explain why cells deprived of nuclei live but a short time and are unable to regenerate missing parts. R. Lillie[4] sought to obtain direct experimental evidence by applying reagents which become colored on oxidation. He found the greatest amount of color in the neighborhood of the nucleus, indicating that it is a center of oxidation. Subsequent workers,[5] using stains which change color on oxidation, failed to agree as to the results.

Mathews[6] has stated that the nucleus is directly concerned in oxidation.

Warburg[7] found that NaOH increased oxidation in the sea urchin egg, but did not penetrate sufficiently to cause a change of color in the interior of eggs stained with neutral red. This is regarded by some as indicating that oxidation is largely confined to the surface of the cell.[8] R. Lillie[9] has recently found that the formation of indophenol in leucocytes indicates that there is rapid oxidation at the surface of the cell as well as at the surface of the nucleus.

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[1] Preliminary communication.

[2] *Pflüger's Archiv*, 67: 615, 1897.

[3] *Archiv für Entwickelungsmechanik der Organismen*, 8: 689, 1899.

[4] *Am. Jour. Physiol.*, 7: 412, 1902.

[5] *Cf.* Wherry, E. T., Science, N. S., 37: 908, 1913; Schultze, W. H., *Verh. deutsch path. Ges.*, 16: 161, 1913; Reed, G. B., *Jour. Biol. Chemistry*, 22: 99, 1915. Unna, P. G. und Godoletz, L., Oppenheimer's *Handb. d. Biochem. Erganzungsband*, *S*. 327, 1913

[6] Mathews, A. P., "Physiological Chemistry," 1915, p. 180.

[7] Warburg, O., *Zeit. f. physiol. Chemie*, 66: 305, 1910; *Biochem. Zeit.*, 29: 414, 1910.

[8] This conclusion does not seem to be necessary. *Cf.* Loeb and Wasteneys, *Jour. of Biochemistry*, 14: 459, 1913; also Osterhout; *Ibid.*, 19: 335, 1914. Owing to the buffer action of the protoplasm and to the presence of pigment the penetration of a small amount of alkali is not easily detected.

[9] *Jour. of Biol. Chemistry*, 15: 237, 1913.

The objection might be made to the use of indophenol reaction that the result may depend somewhat on the manner in which the reagent penetrates. If the oxidizing substances of the cell are largely concentrated in the nucleus, those which are diffused throughout the cytoplasm will first meet the reagent at the cell surface and produce at that point a deposit of granules of indophenol. In the same manner the oxidizing substances which are retained within the nucleus will first meet the reagent at the surface of the nucleus and produce a deposit in that region It would therefore appear that the reaction might be depended on if it showed the nucleus to have the greatest oxidative activity, since its error would lie in the opposite direction. But any conclusions drawn from it regarding oxidation at the surface of the cytoplasm would be of doubtful value.

It would seem that more reliable evidence can be obtained by investigating cases where it is not necessary that the reagent should penetrate from without owing to the fact that the cell itself produces the reagent.

The writer has studied a case of this kind in the Indian Pipe (*Monotropa uniflora*), which is extremely well suited to such investigations, because the cells contain a colorless chromogen which oxidizes and darkens very rapidly upon injury. An additional advantage is that the leaves are so thin and transparent that they may be placed under a microscope and the details of the cell structure studied with care before the cells are injured or treated with reagents.

In a typical leaf cell the cytoplasm is transparent and nearly colorless, with a few granules, while the nucleus is only slightly less transparent, is finely granular and has a nucleolus. When a leaf is mounted in a drop of water under a cover glass the cells remain for hours unchanged in appearance.

If an intact portion of the leaf is cut or crushed the cells in the neighborhood soon change. In the course of five or ten minutes the nuclei of the cells nearest the injury assume a more coarsely granular (or vacuolated) appearance and soon begin to darken. The darkening does not begin at the surface, but appears to take place almost simultaneously throughout the whole mass of the nucleus. Not until the nucleus has become very dark (so as to stand out very conspicuously when the preparation is viewed under the low power of the microscope) does the cytoplasm begin to darken perceptibly. It may be several hours after the nucleus has darkened perceptibly before a change of color can be perceived in the cytoplasm. The darkening of the cytoplasm does not seem to be more rapid at the surface than elsewhere.

That the darkening is due to oxidation is shown by the fact that it is retarded by the partial exclusion of air[10] and is inhibited by the usual means employed to prevent the action of oxidases. When young leaves (free from discolorations) are torn[11] and placed in water the torn edges become dark. This does not occur in 0.1 *M* HCl, 0.1 *M* KCN,[12] 0.1 *M* NaOH, or in boiling water. If the colorless chromogen is extracted by 0.1 *M* NaOH and kept in a tightly stoppered bottle so as to exclude oxygen it remains pale yellow for months, but if oxygen be admitted it soon turns deep red.

That the darkening of the nucleus is due to oxidation taking place in the nucleus itself and not to the taking up by the nucleus of a stain produced in the cytoplasm or vacuoles is shown by the following experiment: Plants were ground in a mortar and allowed to stand until they became black. The juice was squeezed out and centrifuged, giving an inky fluid. In this were placed pieces of leaves which had been treated with 0.1 KCN and then with water. The solution was allowed to stand until it became concentrated by evaporation: it then appeared black. It was found that where the nuclei had been squeezed out of the cut cells by the knife they had taken up some stain but not more than the cytoplasm. In cells which were merely cut open there was little or no staining.

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[10] That the oxidation is not completely inhibited by exclusion of air is doubtless due to the fact that a considerable supply of combined oxygen is present in the cell which can be used for oxidation of the chromogen.

[11] Cutting with a knife was avoided on account of the action of the metal.

[12] In 0.1 *M* NaOH and 0.1 *M* KCN the whole leaf becomes pale yellow and then colorless. The yellow color is doubtless due to the fact that the KCN solution is alkaline.

We must therefore conclude that oxidation occurs more rapidly in the nucleus than elsewhere in the cell. The only way to escape this conclusion would be by assuming that at the moment of injury there is a sudden migration into the nucleus of some or all of the substances necessary for the oxidation. This is not only very improbable from a theoretical standpoint, but observation shows that it can not be the case, for in this migration the substances would mingle and produce the pigment either outside the nucleus, or at its surface, before any pigment appeared in the interior of the nucleus Observation of the nucleus shows that the pigment appears as soon within the nucleus as at its surface.

We may therefore conclude that the substances necessary for oxidation do not suddenly migrate into the nucleus at the moment of injury but that they must exist there before the cell is injured.

We may ask why the nucleus does not become darkened in the normal condition of the cell. The investigation of several workers have made it probable that the pigments produced by oxidation under normal conditions are at once reduced, giving up their oxygen to other substances in the cell. When injury occurs the reduction is checked more than the oxidation, with the result that the pigment accumulates.

It is also probable that in many cases the injury brings the cells into contact with more oxygen than under normal conditions.

In order to compare these results with those produced by the indophenol reagent, leaves were placed in a mixture of equal parts of alpha naphthol (saturated aqueous solution) and para phenylene diamine (1 per cent. aqueous solution). If the reagents are freshly made up there is little action, but if they have stood long enough to take up oxygen or if H_2O_2 is added a purple color develops in the cells, which eventually becomes deeper in the nucleus. The result depends greatly on the condition of the reagent and the rate at which it penetrates the tissue.

The general conclusion is that while the indophenol reaction indicates that the nucleus is the center of oxidation it does not give as definite information on this point as does the formation of natural pigments within the cell resulting from the oxidation of substances normally present.

SUMMARY

Injury produces in the leaf-cells of the Indian Pipe (*Monotropa uniflora*) a darkening which is due to oxidation. The oxidation is much more rapid in the nucleus than in the cytoplasm and the facts indicate that this is also the case with the oxidation of the uninjured cell. W. J. V. Osterhout

Laboratory of Plant Physiology,
Harvard University

SOCIETIES AND ACADEMIES

AMERICAN MATHEMATICAL SOCIETY

At the invitation of Adelbert College and the Case School of Applied Science, Cleveland, Ohio, the twenty-fourth summer meeting of the American Mathematical Society was held at these institutions on Tuesday, Wednesday and Thursday, September 4–6, 1917. This was the society's second visit to Cleveland, the annual meeting having been held there in the winter of 1912–1913. On the present occasion the interest was reinforced by the meeting of the Mathematical Association of America, immediately following on September 6–7. The arrangements, which were in charge of a committee representing both organizations, included a joint session on Thursday morning, at which Professor L. P. Eisenhart presented an address on "Darboux's contribution to geometry," and a joint dinner on Wednesday evening, attended by seventy-six members and friends, to whom President Thwing, of Western Reserve University, spoke a word of welcome, which was followed by a number of informal responses to the calls of the toastmaster, Professor E. V. Huntington. The program on Wednesday afternoon included an inspection of the harmonic analysis apparatus of

Professor Miller, of the Case School, and an organ recital in the chapel. On Thursday afternoon President Thwing gave a garden party in honor of the visiting societies. Luncheon was served on each day at the Case Club, whose building was thrown open to the members afternoons and evenings. At the close of the meeting a vote of thanks was tendered to the authorities of the two colleges for their generous hospitality.

The meeting included the usual morning and afternoon sessions on Tuesday and Wednesday and the joint session on Thursday morning. Sixty-two members were in attendance. At the opening session Professor T. M. Focke, of the Case School, occupied the chair, which was filled in succession by Professors Hedrick, Cajori, G. A. Miller and Eisenhart. Professor Hedrick presided at the joint session. The council announced the election of the following persons to membership in the society: Dr. W. L. Crum, Yale University; Professor T. J. Fitzpatrick, University of Nebraska; Mr. T. R. Hollcroft, Columbia University; E. L. Ince, M.A., Trinity College, Cambridge, England; Mr. L. S. Odell, Manual Training High School, Brooklyn, N. Y.; Dr. T. A. Pierce, Harvard University. Five applications for membership in the society were received.

The following papers were read at this meeting:

Arnold Emch: "On the invariant net of cubics in the Steinerian transformation."

J. E. Rowe: "Theorems related to a point projection of the rational plane cubic curve."

J. E. Rowe: "Closed hexagons related to the rational plane cubic curve."

J. E. Rowe: "The projections of certain points upon the rational plane quartic curve."

Tomlinson Fort: "Some theorems of comparison and oscillation."

O. D. Kellogg: "Oscillation and interpolation properties of solutions of integral equations."

A. B. Coble: "Finite groups determined by $2p+2$ points in S_p."

M. G. Gaba: "Complete existential theory of the postulates of the linear order η."

L. L. Dines: "The bordered Fredholm determinant and the related group of functional transformations."

R. G. D. Richardson: "Contributions to the study of oscillation properties of ordinary linear differential equations of the second order."

C. N. Moore: "On the summability of the developments in Bessel's functions."

G. A. Miller: "Groups formed by special matrices."

Virgil Snyder and F. R. Sharpe: "On the space involution of order 8 defined by a web of quadric surfaces."

R. W. Burgess: "A second approximation for cantilevers."

Florian Cajori: "L. Wantzel."

G. M. Green: "Conjugate nets with equal point invariants."

G. M. Green: "Plane nets with equal invariants."

Florian Cajori: "Newton's solution of numerical equations by the use of slide rules."

L. P. Eisenhart: "Transformations of planar nets with equal invariants."

L. C. Mathewson: "On the group of isomorphisms of a certain extension of an abelian group.

E. D. Roe, Jr.: "Some restricted developments."

E. D. Roe, Jr.: "A geometric representation. Second paper."

E. D. Roe, Jr.: "Integral functions as products."

Mrs. E. D. Roe, Jr.: "Interfunctional expressibility problems of symmetric functions."

E. L. Dodd: "The approximation or graduation of a mortality table by means of a sum of exponential functions."

D. C. Gillespie: "Repeated integrals."

W. A. Hurwitz: "An expansion theorem for systems of linear differential equations."

W. C. Graustein: "Note on isogeneous complex functions of curves."

Mary F. Curtis: "A proof of the existence of the functions of the elliptic cylinder."

John Eiesland: "A Plücker geometry of flats in odd n-space."

H. J. Ettlinger: "Theorems of oscillation for a generalized Sturmian boundary problem."

H. J. Ettlinger: "Theorems of oscillation for the general real, self-adjoint system of the second order."

E. V. Huntington: "Bibliographical note on the use of the word mass in current text-books."

L. P. Eisenhart: "Darboux's contribution to geometry."

Abstracts of the papers are published in the *Bulletin* of the society.

The next regular meeting of the society will be held at Columbia University on October 27. The San Francisco Section will meet on the same day at the University of California. The annual meeting of the Southwestern Section will be held at the University of Oklahoma, Norman, Okla., on December 1.

F. N. Cole,
Secretary

SCIENCE

Friday, October 19, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

THE UTILIZATION OF PATENTS FOR THE PROMOTION OF RESEARCH

On September seventh of the current year an agreement was executed between Dr. T. Brailsford Robertson, professor of biochemistry and pharmacology, and the regents of the University of California, whereby the ownership of his patents covering the growth-influencing substance "Tethelin" which he has isolated from the anterior lobe of the pituitary body, and which, among other possible applications to therapy, promises to be of value in accelerating the repair of slowly healing wounds, was transferred to the University of California, upon the condition that the proceeds or profits which might accrue from their ownership of these rights should be devoted to the furtherance of medical research, such research to be conducted under the immediate direction of a board of directors constituted in the first instance of the undersigned individuals.

The proposal thus advanced by Professor Robertson and accepted by the regents of the University of California constitutes, we believe, a new development in the relationship of science to the industries, and of scientific investigators to the institutions employing them, and we believe that, as such, it should receive the serious consideration of the scientific public, entirely apart from the separate question of the possible merits of this particular invention.

The growing recognition of the intimate dependence of the industries upon science and the increasing complexity and requirements of scientific research itself, have led many to the belief that some modification is desirable of the traditional relationship between the investigator and the material product of his discoveries. In the initiation of such changes, of which the present proposal is one among a number which might be suggested, many serious problems present themselves, and we feel that the solution suggested by Professor Robertson should be subjected to careful scrutiny and the fullest possible criticism. We have accordingly requested Professor Robertson to publish a statement of the fundamental conceptions underlying his proposal, together with the text of the agreement itself. Professor Robertson's statement follows:

H. M. EVANS (Professor of Anatomy),
F. P. GAY (Professor of Pathology),
T. BRAILSFORD ROBERTSON (Professor of Biochemistry and Pharmacology),
C. L. A. SCHMIDT (Research Assistant in Pathology),
G. H. WHIPPLE (Director of the Hooper Foundation for Medical Research and Professor of Research Medicine).

At the present time, as in the historic past, the scientific investigator looks to public or private generosity to supply him with the means of subsistence and the material prerequisites of his work. This relationship of the investigator to the public, while it has been unquestionably fruitful, is nevertheless fraught with many and serious disadvantages. To enumerate but a few of the more salient of these, the investigator is placed in a relationship of direct or indirect dependence upon his patron, a relationship which is not conducive to the best and most complete mutual understanding and appreciation. The income proceeding from these haphazard sources is of variable and unpredictable magnitude, and bears no necessary relationship whatever to the development of our material environment and the concurrent increase in complexity and proliferation in detail of scientific problems. The donors to a greater or less extent modify by their imperfectly informed preferences the channels of expenditure, so that the resources available for the development of any particular field of research are frequently disproportionate to its intrinsic importance.

It is obvious that a much more desirable condition of affairs might be attained if some automatic mechanism could be devised whereby a proportion (and a very small proportion would be sufficient) of the values created by scientific investigation would flow back to provide the material foundations of further discoveries, just as, at the present time, the intellectual foundations of fresh discoveries are automatically afforded by the information flowing in from the discoveries of the past.

A number of separate attempts to achieve this end have already been made, but while the results achieved have frequently been admirable in themselves, they have hitherto failed to afford any precedent which is generally acceptable to scientific men or to the institutions employing them. In some cases individuals have set aside a proportion of the proceeds from their inventions for the support of isolated scientific enterprises, the Solvay Institute in Brussels being a noteworthy instance of this type. In others an institution or an individual affiliated with the institution has entered the commercial field, selling certain articles manufactured in the laboratory, the proceeds from the sales being devoted to the upbuilding of the institution. Illustrious examples of this method of procedure have been afforded by Behring and by Pawlow. The objection to this method lies in the fact that the efforts and attention of the individuals concerned are to a greater or less extent and more or less permanently deflected from their proper business of investigation and that certain dangers and abuses might conceivably arise from the too close identification of the individual and the laboratory in which he works with purely business enterprise.

In other instances, of which Ehrlich's disposal of the proceeds from salvarsan affords the most illustrious example, the discoverer has patented his invention, leased the patents to manufacturers, and dedicated the proceeds to the furtherance of a particular field of research, usually closely allied to the field from which the patented discovery arose. While the result of this procedure in the particular example chosen to illustrate it was in the highest degree successful, and the work accomplished by this means has been of incalculable value to humanity, yet, as a precedent, it has been felt by many that it presents several imperfections, notably that afforded by the association of an individual investigator with a particular business enterprise and the absence of any supervisory control over the commercial exploitation of the discovery.

The industrial fellowships which in recent years have been established in many institutions in the United States and particularly in affiliation with the Mellon Institute of Pittsburgh, represent another stage in the evolution of the relationship between the sciences and the industries. The industrial fellowship plan has proved to be far more widely acceptable as a precedent than any of the plans which I have heretofore mentioned. It is, however, more especially designed to be of direct service to existing industries, to bridge the gap between pure science and industrial progress and to meet the immediate needs of existing industries as they arise rather than to initiate new developments of science itself. Their purpose diverges, therefore, from that of the purely scientific investigator, and while they are of unquestionable value in the field for which they are designed, they leave unsolved the problem of providing automatic support for the development of the deeper foundations of industrial and social evolution.

A plan of wider scope, and applicable to the support either of the pure sciences or of industrial research was launched some years ago by my former colleague Dr. F. G Cottrell, in the form of the Research Corporation of New York,[1] to which he donated certain of his patent rights in his electrical precipitation process. The certificate of incorporation of this company decares that its purposes are:

(*a*) To receive by gift and to acquire by purchase or otherwise, inventions, patent rights and letters patent either of the United States or foreign countries and to hold, manage, use, develop, manufacture, install and operate the same, and to conduct commercial operations under or in connection with the development of such inventions, patent rights and letters patent and to sell, license or otherwise dispose of same and to collect royalties thereon, and to experiment with and test the validity and value thereof and to render the same more available and effective in the useful arts and manufactures and for scientific purposes and otherwise.

(*b*) To provide means for the advancement and extension of technical and scientific investigation, research and experimentation by contributing the net earnings of the corporation, over and above such sums as may be reserved or retained and held as an endowment fund or working capital and also such other moneys and property belonging to the corporation as the board of directors shall from time to time deem proper, to the Smithsonian Institution and such other scientific and educational institutions and societies as the board of directors may from time to time select in order to enable such institutions and societies to conduct such investigation, research and experimentation.

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[1] "The Research Corporation, An Experiment in Public Administration of Patent Rights," Eighth International Congress of Applied Chemistry, New York meeting, October, 1912, Vol. XXIV., p. 59.

The efficient business administration which is thus provided and the separation of the scientific laboratories or investigators from responsibility for the administration of the funds and exploitations of the inventions combine to render the Research Corporation in many respects an ideal means of accomplishing the ends we have in view. It is impossible, however, for purely physical reasons, for the Research Corporation to handle all of the vast variety of profitable inventions, great and small, which issue or may come to issue from the laboratories of the United States, and it would obviously not be in the best interests of research to too greatly centralize the control of the means of its continuance and development. Some system is required which, like the Industrial Fellowship System, is indefinitely reproducible, and adaptable to all of the great variety of learned institutions which might desire to utilize it, so that the system may become an organic part of the investigator's environment and numerous foci come into existence from which the means for the furtherance of investigation may proceed. It was to provide a possible solution of this problem and a precedent which might be acceptable to other investigators and other institutions that the subjoined agreement between the regents of the University of California and myself was drafted.

There are highly profitable discoveries, of course, which are of such a nature as to demand expensive field-trials, or the expenditure of capital to ensure their successful flotation and protection during the period of tentative ultilization. The plan which I have to propose is not designed to deal with inventions of this type, but rather with the equally numerous inventions which are complete in themselves and ready to be leased or sold to existing commercial establishments. Public institutions, holding their funds on trust, can not, of course, enter into speculative enterpises. For dealing with discoveries requiring extensive initial expenditure and the flotation of new commercial enterprises to handle them, the Research Corporation and analogus corporations which may come to be founded for a like purpose provide an acceptable means of ensuring the adequate development of the invention and the return of the proceeds to the support of scientific investigations.

The fundamental administrative basis of the agreement which has been concluded between the regents of the University of California and myself consists in the provision for as complete a separation as is consonant with stability of the responsibility for the business administration of the trust and that for the actual performance of investigations financed from the proceeds of the trust. The successful scientific investigator is usually, for the simple reason of his success as an investigator, a very indifferent financier. The professional administrator or financier, whose interests and information are far removed from the battle-front of the conquest of nature, and whose preoccupation is rather the consolidation of conquests previously achieved, is usually a very indifferent director of scientific investigation. The truth of the former of these propositions will be admitted on every hand; that of the latter is not so generally recognized. It is, however, very clearly evidenced in many contemporary scientific enterprises which, under the too exclusive guidance of professional administrators, are comparatively inefficient in production of results of the highest intrinsic value, while the most successful scientific enterprises of our day are those which are being administered, so far as actual investigation is concerned, by men who are themselves practical investigators of distinction.

In the terms of the agreement it is provided that sole responsibility for every phase of the business administration of the patents and of the proceeds accruing therefrom rests with the regents of the University of California, while the proximate responsibility for the performance of investigations which may be financed by these proceeds rests with the board of scientific directors, under whose immediate direction, subject to the supervisory control of the regents of the university, all researches must be carried out. It is furthermore provided, in order to ensure that the personnel of the board shall consist exclusively of men in living touch with contemporary scientific problems, that the directors shall be persons themselves engaged directly and primarily in research work, and upon ceasing to be so engaged they shall be under obligation to resign as such directors, and if they do not resign their positions shall be declared vacant by the regents of the university. It is furthermore provided that the position of any director shall become vacant upon his attaining the age of sixty years, unless the regents of the University shall, for strong reason existing in the particular case, extend his term of office.

The conquest of nature, which is the material preoccupation of the scientific investigator, is not unlike a military campaign, in that those who retire from immediate contact with operations speedily lose the instincts which underlie and determine practical success. The scientific investigator who ceases to pursue active investigation and turns to administrative or other pursuits, sooner or later loses the intuitions which formerly led him to detect the weak spots in the defense which nature opposes to our inquiry, and that grasp of the field of investigation as a whole which actual contact keeps alive.

A true estimate of any professional man can only be formed by his professional colleagues, and it is therefore provided that any vacancies in the board of directors must be filled on nomination of the remaining members. Such nominees, however, must be approved by the regents of the university, and responsibility for the personnel of the board is thus shared in the fullest possible measure between the members of the board itself and the regents of the university. This provision, and the preceding provisions, are designed to obviate the notorious defects attaching to self-perpetuating boards, while introducing a just sufficient element of self-perpetuation to ensure the perpetuation of the essential character of the present board.

There is a very prevalent misunderstanding even among scientific men, of the true function of the protection extended by patents. While they are designed among other things to ensure a monetary return to the discoverer by granting him a temporary monopoly of his discovery, yet this is only one and not by any means the most successful feature of their purpose. As summarized by Dr. F. G. Cottrell, the basic reasons for granting patents are the following:[3]

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[3] "Government Owned Patents," *Proceedings of the American Mining Congress*, Nineteenth Annual Session, Chicago, Illinois, November 13-16, 1916.

Firstly, to substitute a definite and regulated form of monopoly under the law for the broader and entirely unregulated one which the patentee might otherwise secure by retaining his secret.

Secondly, to encourage and stimulate invention.

Thirdly, to give adequate opportunity and encouragement for intensive commercial development of the invention which is almost invariably necessary to make it generally available on its own merits to the ultimate consumer.

Among medical investigators a very definite prejudice exists against the patenting of any medical discoveries, and this view is to some extent shared by not a few investigators in other fields. The fundamental instinct which leads to this aversion is unquestionably a sound one. It consists in the feeling that monopoly renders possible commercial exploitation, which increases the cost of the article to the consumer disproportionately to the cost of production, while among medical men the word "patent" arouses the repellant idea of the so-called, but mis-named "patent medicine." That notorious abuse is, of course, not patented and should correctly be designated the "proprietary medicine." If existing proprietary medicines were patented (and of course the vast majority, being merely recipes, would not be patentable) their most undesirable feature, that of secrecy, would be at once removed, since, in Great Britain and America at least, the issuance of letters patent is the completest and most accessible form of publication possible. As regards the objection to the feature of monopoly, it is to be recollected that letters patent are only one and not the most efficient among many methods of securing monopoly, and it may be questioned whether the non-issuance of patents would in any important degree lessen the average cost of medical articles to the ultimate consumer. It is, however, to be admitted that the possibility of outrageous extortion from the public does exist and has occasionally been realized in practise. In the subjoined agreement it is, however, provided (subdivision *a*) that the regents of the University of California undertake to utilize the rights granted to them in such a manner as will in their judgment best produce a monetary return and at the same time render the use of the preparation patented most generally available for the benefit of the human race. The regents of the university are thus clearly authorized, in event of their considering it to be desirable in the interest of availability of the preparation for the benefit of humanity, to deliberately sacrifice monetary advantage, and, the element of personal interest being entirely excluded, the public has the fullest procurable guarantee that they would, if occasion arose, take such action.

In subdivision *b* are contained clauses which provide for the reimbursement and "conditional insurance" of the donor. In this particular instance the reimbursement is confined to the repayment of actual expenses incurred, but in many other instances it might very properly consist in a sharing of profits, either expressed as a lien consisting of a cash sum or of a definite sum per annum, or as a percentage of the proceeds, or geographically, the patent rights in certain countries or localities being retained by the donor. The "conditional insurance" clause is inserted to forestall the obvious injustice which might arise were the surviving family of the donor to find themselves in actual need while the university might at that moment be reaping large returns from his discoveries. If, however, the university were to be compelled from the beginning to accumulate a fund to cover this contingency, the result might be, at least for a considerable term of years, to completely stultify the gift and the purposes of the donor. In order to neutralize this it is therefore provided that the university shall not be required to make any provision for this purpose in advance of the actual event of the death or disability of the donor, and the claims of his survivors only become operative at the moment of his death.

In subdivision *c* are included certain individual preference-clauses which, collectively considered, must form an essential and very valuable part of any widely acceptable plan of this nature. In the first place the donor expresses his preference that the proceeds be expended in the furtherance of research on the physiology, pathology and chemistry of growth. This is expressed merely as a preference, however, and is not mandatory. It is merely equivalent to a consistent vote in a certain direction which may, if necessary or advisable, be outweighed by a majority of the votes of the board. It is felt by the writer that the expression of such preference in each and every case of the kind will help to automatically adjust the material resources of the different fields of scientific investigation to their current needs. The donor is usually likely to desire that the proceeds be appropriated to the support of a field of investigation which he considers to be, at that time, lacking in sufficient material support. Such preferences should not be rendered mandatory, however, for the reason that the condition which the donor seeks to rectify may turn out to be only temporary, or the intrinsic importance of the field may ultimately prove to be insufficient to warrant the expenditure of the entire proceeds upon it.

The donor also expresses his preference regarding the locality in which a proportion of the proceeds should be expended. This arises from his conviction that the welfare of scientific investigation, as a whole, demands the widest possible distribution of the facilities for conducting practical investigation.[3] At the present time in New York, London, Paris or Berlin the young man who has capability for original investigation has every opportunity of acquiring facilities for his work and of gaining inspiration from the example of investigations proceeding to a successful issue in his own vicinity and under his own observation. He sees in actual operation the methods of work adopted by masters of his subject, and examples and opportunity alike combine to make the path easy to his chosen career. But what shall we say of the opportunities of the young man or woman in Siberia, China, Australasia, South America or Africa? In certain localities in these countries every necessary institution exists for providing the essential preliminary training of the investigator, but, training in the fundamentals of his subject secured, where is he now to turn for the living example of the successful experimental investigator or for the opportunities of a large and abundantly equipped laboratory, partly or wholly devoted to research? The bare possibility of creating fresh fields of knowledge will probably never even occur to him, since he has never seen or been stimulated to imagine investigation conducted on a broad and practical scale. As a means of tapping new sources of talent for investigation a centripetal disposal of investigators and the opportunities for investigation has become a paramount necessity. The fact that the donor received his fundamental training in Australia determined the preference which he has expressed. It is not rendered mandatory, however, for the reason that it is not clear that the opportunity to so dispose of the proceeds in this particular instance will ever arise, or if it did arise, whether unforeseen political or other events might not, at some time in the future, render this disposal of the proceeds inadvisable.

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[3] "The Strategics of Scientific Investigation," *The Scientific Monthly*, December, 1916, p. 547.

In conclusion, although the plan incorporated in this agreement is applicable to any and all completely developed patentable discoveries which may be made by the employees of learned institutions, the board of directors herein created confines its functions to the administration of *medical* research. It was felt that it would be impossible to choose a board commanding the confidence of investigators in all the various fields of scientific research without making up the personnel by ex-officio appointments, as the dean of this or the professor of that particular college or subject, and thus introducing the very atmosphere of bureaucracy and officialism which it was sought to avoid. In event of this precedent being at all extensively copied it will obviously be necessary, for universities at all events, to establish three or four separate foundations and a like number of boards of scientific directors.

The text of the agreement follows:

T. Brailsford Robertson

This Indenture, made this 7th day of September, 1917, between T. B. Robertson, the party of the first part, and The Regents of the University of California, a corporation, the party of the second part,

Witnesseth:

Whereas the party of the first part is the discoverer of a medical preparation named Tethelin, covered by United States and British patents, and is the owner of such preparation and of such patents and of the trade-name "Tethelin,"

Now, Therefore, It Is Agreed as Follows:

I

The party of the first part hereby conveys and grants to the party of the second part the said preparation, patents and trade-name, and all his rights as the discoverer of said preparation and the owner thereof and of said patents and trade-name, upon the following trust, to wit:

(*a*) To utilise the rights hereby granted in such a manner as in the judgment of the party of the second part will best produce a monetary return therefrom and at the same time render the use of such preparation most generally available for the benefit of the human race. The party of the second part shall have the right to sell or dispose in any other manner of said rights or any of them, in whole or in part, or to grant subsidiary rights and privileges thereunder, either upon royalties or otherwise. The party of the second part agrees that it will use all reasonable diligence to utilise said rights as aforesaid, but it is particularly agreed, and the party of the second part accepts said trust only upon the condition, that it shall be the sole judge as to what is reasonable diligence in the respect mentioned, and that it shall not be pecuniarily or legally responsible for any want of diligence in such respect unless the same be in bad faith or the equivalent of bad faith, and that in view of the fact that the party of the second part is a public eleemosynary corporation all of whose funds are held upon other trusts, the party of the second part shall not be pecuniarily or legally liable under any circumstances whatsoever except to the extent of such rights or the proceeds, profits or returns thereof at the time of recovery against it in the hands of the party of the second part:

(*b*) To apply any proceeds, profits or returns from the utilization of said rights, after paying the expenses of the party of the second part in connection with the trust, to the reimbursement of the party of the first part in the sum of one thousand dollars ($1,000) for expenses incurred by him in making such discovery of such preparation, and, in case of his disability, to the payment to him thereafter for his life of the sum of five thousand dollars ($5,000) annually, and in case of his death to the payment of a like amount to his wife for her life, and in case of the death of both himself and his wife leaving a minor child or children, to the payment of a like amount to such child or children until such child or the youngest of such children shall have reached majority: provided, however, that such annuities shall each year be payable only out of such proceeds, profits or returns as may come in during that year and any balance on hand at the beginning of the year unexpended and unappropriated for the purposes mentioned in the following subdivision (subdivision *c*):

(*c*) To apply any unexpended balance of such proceeds, profits or returns to research work in medicine and preferably in the physiology, chemistry and pathology of growth either under the auspices of the University of California or otherwise, it being the wish of the party of the first part, but not a condition, that in case such proceeds, profits or returns amount to a sum sufficient to justify it, such research work be conducted in part in Australia, either under the auspices of some institution of learning there or otherwise. The party of the second part shall direct such research work in consultation with the men hereafter named as the first members of the board of directors of the Institute of Medical Research whose creation is hereinafter provided for and their successors. The party of the second part shall have the right, subject to the provisions of subdivisions (*a*) and (*b*) preceding, to expend such proceeds, profits or returns on such research work either in whole or in part, holding and investing such accumulation as a fund and expending the income of such fund in the maintenance of research work:

Provided, however, that in case at any time such proceeds, profits or returns are sufficient in the judgment of the party of the second part to justify it, it shall create an Institute of Medical Research which shall, under the immediate direction of a board of directors of five members subject to the supervisory control of the party of the second part, carry on and direct the work of research mentioned. Such Institute, if created, shall also be authorized to conduct other kindred lines of research with funds received or appropriated by the party of the second part for that purpose from other sources, and particularly from the utilization of other discoveries transferred by the discoverers to the party of the second part, provided that in case of conveyance to or acquisition by the party of the second part of other discoveries or patents or rights from which and from the discovery patents and rights hereby conveyed, come proceeds which are joint to both, the party of the second part shall be the sole judge as to the relative proportion of such joint proceeds as are attributable to each of the joint sources thereof. Such board of directors shall in the first instance be composed of F. P. Gay, H. M. Evans, G. H. Whipple, C. L. A. Schmidt, and the party of the first part. Any vacancy in said board shall be filled on the nomination of the remaining members approved by the party of the second part. The directors shall be persons themselves engaged directly and primarily in research work either of the character mentioned or of some kindred character, and upon their ceasing to be so engaged they shall be under obligation to resign as such directors, and if they do not resign their positions shall be declared vacant by the party of the second part and upon such declaration shall be vacant. The position of any director shall become vacant upon his attaining the age of sixty (60) years unless the party of the second part shall, for strong reasons existing in the particular case, extend his term of office.

II

The party of the second part accepts the foregoing grant and conveyance upon the trust above set out.

In Witness Whereof the party of the first part has hereunto signed his name and the party of the second part has by its officers thereunto duly authorized hereunto signed its corporate name and affixed its corporate seal all on the day and year first above written.

T. Brailsford Robertson,
The Regents of the University of California,
By Wm. D. Stephens,
Governor of the State of California, and ex-officio President of the Regents of the University of California,
By V. H. Henderson,
Secretary of the Regents of the University of California

SCIENTIFIC EVENTS

JOSEPH YOUNG BERGEN

Joseph Young Bergen, author of several well-known text-books of botany and physics, died at his home in Cambridge, Mass., on October 10. Born at Red Beach, Maine, on February 22, 1851, he spent his youth in Ohio, where in 1872 he graduated from Antioch College, and where in connection with the State Geological Survey he performed his first scientific work. In 1876 he married Fanny Dickerson, who has collaborated with him in the production of several of his papers on evolution and Darwinism, and who herself has made notable contributions to the literature of American folklore In 1887 Mr. Bergen became teacher of physics in the Boston Latin School and later for many years he was instructor in biology in the Boston English High School.

In 1891, in collaboration with Professor E. H. Hall, of Harvard University, he brought out "A Text-book of Physics." This had passed through subsequent editions in 1897 and 1903, and is still widely used in secondary schools.

His first biological text-book, "Elements of Botany," appeared in 1896 and its excellence was speedily recognized. With some modifications it was subsequently republished under the name of "Essentials of Botany," and in 1901 Mr. Bergen brought out his "Foundations of Botany," including a condensed flora for school use. Other text-books with special adaptation for schools of particular grades of scientific equipment were later published by Mr. Bergen with the collaboration of Dr. Otis W. Caldwell and Professor Bradley M. Davis.

By his long personal experience in the difficulties of the presentation of the subject of botany in the secondary school Mr. Bergen was able to frame these text-books in a way to meet both the needs of teacher and pupil and it is doubtful if any other texts have been more widely used or met with a greater success during the last two decades in the field which they cover.

THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS

The American Association of Variable Star Observers concludes this month six years of active service with a record of 15,763 observations of 332 variable stars for the year, and a grand total for the six years of 75,373 observations.

The past year has been one of marked progress in the efficiency of the scientific service rendered and growth in the membership of the association.

A meeting of the association will be held at the Harvard College Observatory, Cambridge, Mass., at 2 P.M., November 10. At this meeting a constitution and by-laws will be adopted and officers elected. Seventy-two observers have already enrolled as charter members and a cordial invitation is extended to all interested in the work to be present at the meeting. It will be a splendid opportunity to inspect through the courtesy of the director, Professor E. C. Pickering, the historic Harvard College observatory and to see exhibits of great interest to all astronomically inclined.

The undersigned will be pleased to answer any questions relative to the work of the association and will be glad to hear from any one who wishes to join the organization, and take up a line of telescopic work that is teeming with interest, devoid of mathematics and intricate detail, and eminently worth while.

William Tyler Olcott,
Corresponding Secretary

Norwich, Conn.

THE CORNELL MEDICAL SCHOOL

Cornell University Medical College opened its twentieth session on October 1, 1917. The student assembly was addressed by Dr. William H. Polk, the dean, who discussed the relation of the medical college to the present military situation and outlined the opportunities for patriotic service by students of medicine. The attention of the student assembly was called to the active participation in the work of the United States of America by the college, the members of the faculty and the medical graduates by active service in the field and by providing facilities for the instruction of officers of the Medical Reserve Corps. The entering students were exhorted to continue their course, that, in accord with the announced plan of the authorities, they may be prepared to fill the vacancies in the medical ranks which, with the continuance of the war, are certain to arise. The enrollment is as follows: First year, registered in New York, 38; registered at Ithaca, 30; total, 68; second year, 34; third year, 29; fourth year, 27; graduates in medicine, 4; total, 182. All students registered for the degree of M.D. (with the exception of those in the first year who are taking the seven-year course leading to the degrees of A.B. and M.D.), are graduates in arts or science. As a result practically all members of the first-year class fall within the limits of the military draft. Several students, having been drafted into the National Army, or fearing the draft in the immediate future, failed to register.

A SCHOOL FOR ORAL AND PLASTIC SURGERY

By order of the surgeon general of the army an officers' school for oral and plastic surgery has been established in St. Louis. The purpose of this new school is to train a limited number of the medical reserve and perhaps other medical officers for the care of those peculiar wounds of the face and jaws characteristic of trench warfare. Both surgeons and dentists will enter upon this work and will eventually constitute a section of the staff in every base hospital and evacuation hospital in connection with the army. The plan involves the training and placing of a sufficient number to care for the face injuries presented among a million men in hospitals. Major Vilray Papin Blair, of St. Louis, has been called to Washington to organize and direct this important work. The first school has its headquarters at the Washington University Medical School, which at the beginning of the war offered to the government the facilities of its new laboratories, hospitals and clinics, and the services of its faculty. Instructors have been chosen chiefly from the faculties of Washington University Medical School and St. Louis University School of Medicine and the special curriculum has been adopted. The latter offers intensive work in anatomy, operative surgery, sepsis, anesthesia and dentistry. The first course will begin on Monday, October 15, and will extend over a period of three weeks to be repeated until the number of men desired has been reached. The surgeon general has designated for dean Dr. R. J. Terry, professor of anatomy in the Washington University Medical School, and for chairman of the curriculum committee, Dr. Hanau W. Loeb, dean of the St. Louis University School of Medicine; Dr. Ernest Sachs, associate professor of surgery at Washington University Medical School, to serve as secretary of the council.

THE RED CROSS MEDICAL SERVICE

THE establishment of a bureau of medical service of foreign commissions to give prompt and expert attention to the requests for medical and surgical supplies received from American Red Cross commissions now at work in France, Russia, Roumania, Italy, and Serbia is announced by the Red Cross war council. Requests for additional doctors and nurses for service with these commissions, particularly in France and Roumania, will also be handled by the new bureau.

In cooperation with the medical advisory board, the bureau will also render assistance in the solving of many new pathological problems constantly arising out of the war.

Dr. R. M. Pearce, of Philadelphia, professor of research medicine at the University of Pennsylvania, is director of the new bureau: Dr. W. C. Bailey, of Boston, associate director; and Dr. Ralph Pemberton, of Philadelphia, assistant. The secretary of the bureau is John Gilbert, of Philadelphia.

The growth of the work of all the Red Cross commissions in European countries during the last two months made the establishment of this bureau necessary. Drugs and medical supplies to the value of more than $500,000 have already been shipped to Russia, while three detachments of child specialists have been recruited throughout the country for service with the new children's bureau of the Red Cross in France. The bureau is furnishing bacteriologists, chemists, surgeons, and others for Red Cross establishments in Paris.

SCIENTIFIC NOTES AND NEWS

THE chairman of the committee on policy of the American Association for the Advancement of Science has requested Professor Cattell to continue to edit SCIENCE until the questions involved have been carefully considered by the committee on policy and the council of the association.

AT the annual meeting of the national advisory committee for aeronautics held recently, Dr. W. F. Durand was reelected chairman and Dr. S. W. Stratton was reelected secretary. Members of the executive committee were elected as follows: Dr. Joseph S. Ames, Dr. Charles F. Marvin, Dr. Michael I. Pupin, Major General George O. Squier, United States Army, Dr. S. W. Stratton, Rear Admiral D. W Taylor, United States Navy, and Dr. Charles D. Walcott. At the organization meeting of the executive committee Dr. Charles D. Walcott was elected chairman and Dr. S. W. Stratton, secretary. Existing subcommittees were continued, and an editorial committee was appointed to prepare for publication the technical reports.

Major George E. deSchweinitz, Medical Reserve Corps, has been assigned to active duty at Philadelphia for the purpose of compiling a handbook on ophthalmology for the use of the surgeon-general of the army.

Frederick B. Mumford, dean of the Missouri College of Agriculture, director of the experiment station of the University of Missouri, and chairman of the Missouri council of defense, has been chosen federal food administrator for Missouri.

The deputy-controller for auxiliary shipbuilding, of the British admiralty, has appointed Lieutenant-Colonel J. Mitchell Moncrieff to be director of engineering work, to deal generally with all civil engineering matters which may arise in connection with his department.

The post of director of food economy at the Ministry of Food of Great Britain has been undertaken by Sir Arthur Yapp, the national secretary of the Y. M. C. A.

Among the members of the faculty of the University of California Medical School who have been called into active service in the Medical Officers Reserve Corps are Dr. Herbert C. Moffitt, San Francisco, professor of medicine and dean of the medical school, who has been commissioned major, and stationed at the Army Hospital at San Antonio, Texas; Dr. Eugene S. Kilgore, who has been commissioned major, and is stationed at the Presidio in San Francisco; Dr. Alanson Weeks, instructor in surgery, commissioned major; Dr. Howard E. Ruggles, assistant clinical professor of roentgenology, and Dr. Jule B. Frankenheimer, instructor in medicine, commissioned captains; and Drs. Elbridge J. Best, Frank P. Brendel, Arthur C. Gibson, Charles L. Tranter and Daniel W. Sooy, commissioned first lieutenants.

The faculty of applied science of Columbia University has lost, temporarily at least, many of its officers, who are now engaged in government work. · Professors Moss, Sleffel, and Thomas, of the department of mechanical engineering, and Mr. Mason, of the department of electrical engineering, are instructors, with the rank of lieutenant, in the naval reserve, in the naval engieering school conducted on the campus; Professor Arendt, of the department of electrical engineering, is in charge of electrical instruction at the submarine base at New London; Professor Webb, of the department of physics, is a captain in the Signal Corps; Dr. Thomas, of the department of chemistry, and Dr. Burwell and Mr. Brown, of the department of sanitary engineering, are in the sanitary corps of the army; Professor Beans, of the department of chemistry, and Mr. McGregor, of the department of civil engineering, are in charge of chemical and mechanical tests for the Aircraft Production Board; Professor Campbell, of the department of metallurgy, is consulting metallurgist for the navy, and Professor Walker, of the department of metallurgy, is in the ordnance department of the army.

The Maryland Geological and Economic Survey Commission, which consists of the governor of the state, the presidents of the Johns Hopkins University and the Maryland Agricultural College, and the state comptroller, has elected Professor Edward Bennett Mathews, for many years assistant state geologist, as state geologist to succeed the late Wm. Bullock Clark.

As a war emergency measure the National Forest ranges are carrying this summer approximately 100,000 more cattle and 200,000 more sheep than in ordinary years, according to the grazing experts of the forest service. Ordinarily the National Forests furnish pasturage for about 1,800,000 cattle and horses and 7,800,000 head of sheep. The number of livestock permitted on the forests is limited in order to prevent damage to timber growth, water supplies and the range itself. This year exceptional weather conditions combined with the general food situation to create an unusual emergency, calling for special provisions to take care of the stock. A severe winter and late spring exhausted the hay supply and forced use of the spring ranges before they had reached their normal state. To lessen the losses which the western livestock industry faced, the National Forest ranges were opened early. At the same time, the number of stock permitted for the present season was raised to the maximum consistent with safeguarding future productiveness. It is fully recognized that the increases which have been made in the allowances of stock on the national forests involve danger that the range will be depleted through overgrazing, but it is believed by the grazing experts of the government that the emergency increases made can be taken care of, at least this year, without material sacrifice of productive capacity. The condition of the ranges is, however, being carefully watched. Reliance is placed also on the special efforts being made to secure the most intensive utilization consistent with sustained productiveness, by improved methods of handling the stock. Better salting methods and the development of new watering places are among the means employed for this purpose. At the close of the grazing season a careful examination will be made of the range on each forest to determine its condition and to find out how many cattle or sheep it will support next season. On areas which are found to be overgrazed, an attempt will be made to shift the surplus stock to range which can stand the strain better. While the grazing officials do not think that the increase could be carried indefinitely without serious damage to the forage, regulated grazing has brought about a steady improvement of the range and some areas will probably be able to support the larger numbers permanently.

DURING the last week of September nine industrial fellows of the Mellon Institute of Industrial Research entered the service of the government. The names of these men, all of whom are chemists, are as follows: Dr. Frank O. Amon, Dr. Harold S. Bennett, Mr. A. S. Crossfield, Mr. W. J. Harper, Mr. C. E. Howson, Dr. R. W. Miller, Mr. Ray V. Murphy, Mr. W. E. Vawter and Mr. C. L. Weirich. Messrs. Amon, Bennett, Howson, Miller, Murphy, Vawter and Weirich have received commissions as first lieutenants. In addition, three other Industrial Fellows, Messrs. C. O. Brown, G. F. Gray and R. P. Rose had previously been commissioned as captains; A. H. Stewart has entered the aviation service and C. N. Ivy has been appointed a second lieutenant in the Engineering Corps.

THE dean of Sibley College, Cornell University, Professor Albert W. Smith, has received leave of absence for the year 1917–18 in order that he may serve as consulting engineer to the Mathieson Alkali Works at Saltville, Virginia. Professor Dexter S. Kimball, head of the department of machine design and industrial engineering, has been appointed acting dean of Sibley College.

PROFESSOR J. C BRADLEY, of Cornell University, and Professor Edwin C. Van Dyke, of the University of California, have exchanged work for the current year. Although both are general entomologists, Professor Van Dyke is an authority on the coleoptera, while Professor Bradley is a specialist on the hymenoptera.

PROFESSOR JOHN C. MCLENNAN, Ph.D., head of the department of physics of the University of Toronto, and member of the Canadian Commission on Chemical Research, is among the first group to receive the honor of the new Order of the British Empire.

THE Medical Club of Philadelphia will give a reception in honor of Dr. Morton Prince, of Boston, on October 19, at the Bellevue-Stratford Hotel.

DR. SANTOS FERNANDEZ, president of the Cuban Academy of Science, and one of the most distinguished eye surgeons of Cuba, was the guest of honor at a luncheon given October 2, by Dr. William Campbell Posey, of the Wills Eye Hospital, Philadelphia.

ACCORDING to *Nature*, the seventieth birthday of Professor S. Hoogewerff, formerly rector of the Technical High School of Delft, was recently celebrated by his friends and pupils. Professor Holleman briefly reviewed Hoogewerff's work, carried out conjointly with the late Dr. Van Dorp, on the cinchona alkaloids, on isoquinoline, and on the production of anthracilic acid from phthalimide. The latter reaction became a step in the manufacture of synthetic indigo. On behalf of a number of Dutch chemical firms, Dr. Van Linge, manager of the Maarssen quinine works, announced that more than £8,000 had been subscribed for the foundation of a prize for chemistry at the Technical High School at Delft, in order to commemorate Professor Hoogewerff's services to this institution and to Dutch chemical industry.

Having completed the report upon the geology of southern California for the U. S. Geological Survey upon which he has been engaged for several years past, Robert T. Hill has opened an office for the practise of his profession of geologist at 702 Hollingsworth Building, Los Angeles, Cal.

Mr. W. H. Fegely, for several years instructor in chemistry and assistant director of the laboratories at Allegheny College, has resigned his position to take charge of the research laboratories of the Erie Malleable Iron Company, Erie, Pa.

Shirley W. Allen, of the extension department of The New York State College of Forestry at Syracuse University, has been appointed, temporarily, to succeed Victor A. Beede as secretary of the New York State Forestry Association. Mr. Beede has gone into forest fire insurance work at Portsmouth, N. H., and Mr. Allen will act as secretary until the midwinter meeting to be held some time in January, 1918.

Professor J. A. Fleming delivered a public lecture on "The work of a telephone exchange" at University College, London, on October 17.

The death is announced, at fifty-six years of age, of Mr. R. D. Pullar, president of the British Society of Dyers and Colorists in 1914, and chairman of the well-known firm of Messrs. J. Pullar and Sons, dyers and cleaners, at Perth. Mr. Pullar was a life fellow of the Chemical Society of London.

The death is also announced of A. da Graça Couto, professor of ophthalmology at the University of Rio de Janeiro and director-general of the public health service, aged fifty-three.

The Evening Post says that France presents the interesting spectacle of a country in which three of the most important posts in government and army are filled by men whose qualifications include a remarkable proficiency in mathematics. The new Premier, M. Painlevé, was as precocious as a Pascal in that branch of knowledge, says the *Christian Science Monitor*. He knew enough at eleven and a half to have got his bachelor's degree, and later on he was a cause of amazed admiration to no less a person than Henry Poincaré. Then there is the commander-in-chief General Pétain, whom M. Painlevé, when Minister of War, chose to lead the French armies in the final and perhaps most difficult stage of the war. He also is a fine mathematician. Finally there is M. Loucheur, the new minister of armaments, and he did nothing less while at the Ecole Polytechnique than discover a new theorem on epicycloids. This is more than coincidence, it is significant of the direction in which the new France intends to travel.

The Engineering Corps is looking for 10,500 men with road-construction experience to serve in an engineer brigade which is soon to go to France to do roadbuilding work with General Pershing's expeditionary force. The regiment will be made up entirely of volunteers. No man actually called for military service is eligible. Rapid advancement is promised men with special qualifications, and a few college men, preferably with military experience, are wanted as non-commissioned officers.

The *Journal* of the American Medical Association states that the Swiss Société helvétique des Sciences naturelles, which was the original model on which Virchow founded the German organization which meets once a year for what are popularly called the *Naturforscher* congresses. The venerable Swiss association now announces the formation of a section or subsociety devoted to medical biology, to be known as the Société de Médecine et de Biologie. Professor Hedinger of the University of Basel is the moving spirit in the matter. The inaugural meeting is to be held this month at Zurich. It is hoped for a large membership among physicians interested in medical biologic questions.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of Mrs. E. D. Denning, of Norwood, London, who left an estate of the gross value of £167,719, there is bequeathed "to the Public Trustee all her freehold property in trust for a 'Frank Denning Memorial' for the advancement and propagation of education in mechanical science in any part of the United Kingdom, with preference to those persons who reside in the Borough of Croydon."

English exchanges report that Lord Lovat, Mr. Otto Beit and Mr. Rudyard Kipling have accepted the positions of trustees under the will of the late Mr. Cecil Rhodes in succession to Lord Rosebery and Sir Lewis Mitchell, who resigned recently, and of the late Earl Grey, who had resigned shortly before his death. The trustees have decided to allot the four new scholarships created in substitution for the scholarships formerly held by Germans to the provinces of Alberta and Saskatchewan, to the Transvaal, to the Orange Free State and alternately to the towns of Kimberley and Port Elizabeth in the Cape Province. As Alberta and Saskatchewan have hitherto had one scholarship between them, the effect of this decision will be that each of these provinces will now have a scholarship. The trustees have decided not to make any appointments to any scholarships this year, either in the United States or in any part of the British empire, although the qualifying examinations in the United States will be held as already arranged. This decision is based upon the fact that as all candidates must be men of military age it would not be in accordance with the spirit of the testator's design if young men who first responded to the call of patriotism were to be penalized for having done so. Any candidate who is eligible this year will be equally qualified for election next year.

No successor to the late Professor Wm. Bullock Clark will be appointed at the Johns Hopkins University. The geological department has been reorganized on a committee basis with Professor Edward Bennett Mathews as chairman and Associate Professor J. T. Singewald, Jr., as secretary. The instruction formerly given by Professor Clark has been divided among the geological faculty, Professor Edward W. Berry taking his work in paleontology and historical geology.

At Pennsylvania State College, David Allen Anderson has been chosen professor of education and head of the department of education and psychology. Dr. Anderson was previously associate professor of education in the University of Washington.

Professor George B. McNair is acting head of the department of electrical engineering of Colorado College during the absence of Professor George B. Thomas.

Dr. William Shiner, superintendent of the pathological laboratory of the Indiana State Board of Health, has been offered the professorship of pathology in the University of Texas.

Dr. Samuel A. Matthews, professor of physiology and experimental pharmacology in the University of Kansas, Topeka and Lawrence, has accepted the similar chair in the University of Alabama, Mobile.

Dr. Francis M. Van Tuyl, formerly instructor of geology in the University of Illinois, has recently been appointed an assistant professor in the Colorado School of Mines, at Golden.

Bernard A. Chandler, of the Vermont Agricultural Experiment Station, has been appointed assistant professor of forest utilization in the department of forestry of Cornell University.

W. G. Brierley, chairman of the division of horticulture, department of agriculture, University of Minnesota, has been promoted to the rank of associate professor.

Dr. Florence Peebles, professor of biology at Newcomb College, Tulane University, has been appointed associate professor of physiology at Bryn Mawr College.

Dr. J. Lucien Morris, formerly associate in biological chemistry at the Washington University Medical School, has accepted the position of associate in physiological chemistry at the college of medicine, University of Illinois.

A chair of tuberculosis has been instituted by the Edinburgh University Court, and Sir

Robert Philip has been appointed as the first professor of the subject.

DISCUSSION AND CORRESPONDENCE

ISOLATION CULTURES WITH SMALL AQUARIA

WHEN raising small forms of vegetable or animal aquatics, it is sometimes desirable to follow the development of several individuals simultaneously, and for some considerable time. This can done of course by removing the specimens to separate small aquaria, but by so doing the temperature and other conditions are likely to offer a considerable range of variation among the different specimens. This invites uncertainty as to the natural rate of development, or in response to any intended variable introduced by the experimenter. The desirable condition is to combine a considerable volume of water with isolation of individuals so that each specimen may have essentially identical conditions of temperature, and concentration as each other, in groups of eight to twelve individuals.

During a study of *Lemna* carried on for several months, it was desired to isolate individual plants in order to watch the rate of growth. As the frond floats freely, some method by which the surface of the water could be enclosed in distinct areas seemed likely to meet conditions. It was found that common cotton cord, waxed with parafine, and tied into loops two inches in diameter, were excellent for this work so long as the water was undisturbed. Any disturbance, however, either accidental or in course of the work, by which the upper surface of the string loops become wet, made these sink quickly after they had been in use two or three days, and the enclosed specimens would then be confused with any others which might be near. Small snails developing in pond water used were quite a source of loss of specimens by their destructive habits, as well as factors of uncertainty, through the displacement of the string loops, drawn below the surface by the movement of the snails in case these crawled across the strands. The vessels used at this time were common glass battery jars, and served very well in keeping the plants in good condition, but they were unnecessarily deep.

Later work was done with large crystallizing dishes, and the separation of individuals was secured by the use of glass dehydrating dishes with short legs and perforated bottoms, for inside dishes. This was found very satisfactory. The volume of water in the crystallizing dish was large enough to retain a much more steady temperature than did the small separate dishes tried for a time, and the perforated walls of the enclosing inner dishes permitted the movement of the water with sufficient freedom to eliminate any variable concentration or composition.

In securing single specimens for the isolation work, some interesting conditions were encountered on account of the toughness of the water film. It was found difficult, for example, to lift a single specimen of *Lemna* or *Wolffia* because the surface film would drag several additional specimens along with the desired individual. This trouble was largely eliminated by giving a smart puff of breath close to the desired specimen, which would cause a general scattering of all the floating particles from that point. As the elasticity of the film was released upon the cessation of the blowing, the dispersed specimens were drawn inward toward the center of the cleared area. On account of size, root development or other causes, the different specimens did not move with equal speed, and any one of the specimens first entering the cleared space could be lifted and removed with ease. It was found that a lance-head needle was an excellent lifter for the specimens.

Of three species under observation, *Wolffia* was the easiest to thus isolate, *Lemna paucicostata* next, and *Spirodella* the most difficult to lift with certainty. This is because *Wolffia* is completely immersed in the slight amount of water adhering to the needle, and sticks closely as this is raised from the dish. The single root of *Lemna*, and the many roots of *Spirodella*, prevent the fronds of these plants from so closely adhering to the flat needle. and their added weight also is adverse. It was found further that a dry needle was far more satisfactory than one which was wet when introduced into the dish. The water on the needle would promptly unite with the surface water in the dish, and several specimens would then be lifted from the dish in nearly every case, unless previously puffed away with the breath. But by wiping the needle, the individual plant desired can often be lifted out even if others are so near as to nearly touch the selected plant.

The dehydration dishes within the crystallizing pans proved very satisfactory, and permitted the continued cultivation of the particular strain under observation for a considerable period. Frederick H. Blodgett

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TWO METHODS OF ORIENTATION OF SMALL OBJECTS IN PARAFFIN

The following method is applicable to all objects which are sufficiently small to admit of embedding in watch crystals. It has been found practical and easy and is given here in the expectation that it will be of assistance to others.

Watch crystals of the Syracuse type with flat bottoms are employed. On the bottom, parallel lines about 2 mm. apart are ruled with a diamond. These are then scraped out with a coarse needle, the sharp edges being broken off and the lines widened to form open grooves. The watch crystals should be washed to remove the small particles of glass and are then ready for use. The watch crystals are prepared for embedding by coating the interior with a film of glycerin as usual, but care must be taken to rub the glycerin into the lines. When infiltration is complete, the watch crystal containing the objects is removed from the oven and the bottom slightly chilled by contact with cold water. It is then placed on the stage of a binocular microscope and the objects oriented with a warm needle, so that the plane of section desired shall be parallel with the lines and normal to the bottom of the watch crystal. As soon as the paraffin on the bottom has cooled sufficiently to hold the objects in place, the entire mass is cooled with water in the usual manner. In orienting the objects it is found that the lines on the bottom of the watch crystal show more distinctly by transmitted than by reflected light. The block when removed shows on its lower surface minute parallel ridges which enable accurate and easy orientation when mounted on the object carrier of the microtome. The block should of course be placed in the microtome with the ruled surface upwards and then arranged with the lines parallel with the edge of the knife and the surface at right angles to the direction of motion, that is horizontal in the ordinary vertical type of Minot microtome, vertical in the horizontal type.

A second method, or variation of the method given above, is to rule the parallel lines on the watch glass with a "china-marking" pencil. These lines, even though the glass is thoroughly coated with a glycerin film, will come away with the paraffin block and may be used as orientation lines. This method may also be used for numbering or otherwise marking paraffin blocks.

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THE AURORA BOREALIS

To the Editor of Science: The display of the aurora borealis mentioned by your correspondent, Mr. Thomas Byrd Magath, in Science, No. 1186, as seen at Fairport, Ia., on the ninth of last August at about 8.45 (Central time?) was also observed by the writer and others from a yacht anchored at Thimble Islands (Stony Creek), Conn., at about nine, 75th meridian time, of the same evening. The display was quite brilliant, although the streamers did not reach much above 50° in altitude. The region of greatest brilliancy was about N. 25° W., true.

On August 14 at about the same time a more brilliant display was seen at Stonington, Conn. (Lat. 41° 19′). The illumination reached much further to the eastward and the streamers were higher. At times masses of pale light detached themselves from the general illumination and rose with a quivering flame-like motion almost to the zenith where they disappeared, to be succeeded by others in turn. These waves appeared to be about 10° to 30° in a horizontal direction and perhaps 2° in the vertical direction. The display was observed by us until about ten and we were told by a fisherman who was out all night that it lasted until nearly three in the morning.

On August 25, at Clinton, Conn. (Lat. 41° 17′), we observed a still more brilliant display at 8.40. There was an arch of greenish-white light whose center bore nearly north, true, the portion of sky enclosed by the luminous arch being entirely dark. Streamers of considerable intensity were observed and the light from the arch was sufficient to illuminate the whole bay, rendering objects 300 yards away distinctly visible. At times above the greenish-white light, light varying from pale pink to deep red was observed, but chiefly on the eastern side of the meridian and high up, at least 75°. Suspecting that the latter phenomenon might be an illusion due to a complementary after-image of the brighter display lower down, we examined it carefully with the light from the rest of the display cut off for a considerable time but could not see that this made any difference. The display was observed until 9.40, when it had not ceased.

Are not these phenomena, *i. e.*, the dark segment below the bright arch and the pink color, unusual in such low latitudes?

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SCIENTIFIC BOOKS

Experimental Pharmacology. By DENNIS E. JACKSON, Ph.D., M.D., Associate Professor of Pharmacology, Washington University Medical School, St. Louis. St. Louis, C. V. Mosby Company. 1917. Pp. 536, with 390 illustrations. Cloth. Price $4.

Scientific text-books may be conveniently grouped into two classes: the majority have for their object the adequate, concise and clear presentation of the principal facts and data concerning the subject they deal with, in logical order and with a due regard to their relative importance. Such works are generally impersonal in character and introduce the author's views only incidentally in connection with the sections dealing with the particular lines of work in which they have been interested. Another class of text-books, however, may be characterized as distinctly "individualistic" in style and seem to have for their purpose primarily the exposition of the author's methods and views, relegating all other matter to a secondary place. Such a presentation of the subject is perhaps a natural one for the pioneer in a new domain of science and may be exemplified in case of pharmacology by Schmiedeberg's well-known little book, but when a science has once reached a high development, as is true of the pharmacology of the present day, this form of treatment in any hands but those of a great master is apt to become somewhat one-sided and provincial.

Within the last few months we have seen the publication in this country of two text-books on pharmacology which well exemplify the two classes just mentioned. Sollmann's "Manual of Pharmacology and Laboratory Guide"—the recent new edition of his older work, greatly amplified, revised and rearranged—is an excellent example of scientific exposition belonging to the first or "impersonal" class.

Jackson's "Experimental Pharmacology," on the other hand, is certainly "individualistic" in character, and must be put in the second class described above. It is not an ordinary "text-book" of pharmacology but is preeminently *Jackson's* text-book of pharmacology. The personality of the author is patent on almost every page of it; and therein are expressed both the merits and the demerits of the work. On the one hand, even a superficial examination of the treatise reveals, as is well known, that the author is a master of technique and the descriptions of various devices and experiments originated or improved by him are, in so far as they are new, illuminating and useful. On the other hand, the author unfortunately, in exactly the same manner as he treats new and original manipulations, also expatiates upon non-essentials and indiscriminately devotes a great deal of valuable space to detailed and minute descriptions of ordinary experiments well known to every physiologist and pharmacologist, conveying the impression as if the methods taught by the St. Louis school were the only and the best.

The mass of unimportant details which are crowded into the book is surprising and it is doubtful whether they will prove profitable even to the student. It is a truism that no experimental science can be learned from a text-book and it is inherent in the nature of experimental investigation that subordinate details of various procedures have to be modified under various circumstances and conditions. It is very doubtful, therefore, whether pages of detailed description of *every* step in a given experiment may lead to a better grasp of its general features Indeed, such didacticism may endanger the principal purpose of the exercise by diverting the student's attention from the main features of the problem. Many minutiæ should be best left to the common sense of the experimenter, and will be learned by the beginner on the first day he spends in the laboratory. A single demonstration in the lecture room or the workshop will teach the student more than a hundred pages of detailed description. For this reason long descriptions with illustrations of how to tie an animal on the operating table and similar incidental and trite matters seem to us trivial and entirely superfluous. Such directions might possibly be found useful by a self-made pharmacologist on an isolated island—a Robinson Crusoe with pharmacological tendencies—with no one to guide him, but are needless and purposeless in a country where good teachers are to be found and well-equipped laboratories are accessible.

The title "Experimental Pharmacology" as applied to the present work seems to one familiar with pharmacological text-books to be somewhat misleading. One unconsciously expects to find a work along the lines of the "Experimentelle Pharmakologie" of Meyer and Gottlieb, namely, a logical presentation of important pharmacological facts based upon the best modern experimental data. Jackson's book is in reality a laboratory manual which aims to present pharmacological deductions in connection with typical experiments described by the author. This fact explains best the rather one-sided character of the work, for in presenting the subject the author has laid the greatest stress upon the experiments in which he is an adept, and along the lines in which he has been personally interested. Thus, for instance, the whole group of heavy metals (iron, mercury, arsenic, etc.) is practically untouched in the text-book: they are not even mentioned in the index. On the other hand, the comparatively unimportant minor element or metal, vanadium, with which the author has done some work, receives considerably more attention than it deserves.

An extraordinary feature of Jackson's "Pharmacology" is its wealth of illustrations. The book is listed to contain 536 pages, including 390 illustrations. As many of the cuts are full-page, the drawings occupy about half of the book. Some of these are well executed and should prove extremely useful. This is especially the case with the reproductions of careful and complicated dissections and various schematic illustrations of nerves, blood vessels and other structures with which the book abounds. Furthermore, the drawings of new and original methods for studying circulation, pulmonary pressure, anesthesia, etc., will also be found of help. The diagram of the involuntary nervous system (p. 385), however, is not as lucid and explicit as that of Langley or the modifications of the latter to be found in Meyer and Gottlieb's "Pharmacology." A large number of kymographic tracings are also a distinctive feature of the book, but here again the author's personality is perhaps unduly accentuated by their selection. Thus we have noted some twenty or more tracings scattered promiscuously throughout the book, which illustrate broncho-constriction and broncho-dilatation, a method of experimentation for which the author has become well known. While many of the illustrations are well chosen and instructive, a large number may be found interspersed among them which we deem entirely superfluous. We fail to discern the purpose served by pictures of a "graduated cylinder," a "beaker," a "burette and rubber tubing," a "specimen jar," "small wooden tables," a "casserole," a "scalpel," a "hemostat," an "evaporating dish," or of clamps, forceps, screws, scissors, oxygen tanks, hand bellows, bottles for holding stock solutions, and similar common utensils with which every student and laboratory boy becomes familiar as soon as he enters the class-room. Such illustrations could be obtained at a much less expense, if need be, from any laboratory supply dealer, by writing for an illustrated catalogue.

Barring the unnecessary mass of subordinate detail in the text and illustrations, Jackson's treatise has certain admirable features. The style of the author bespeaks his intense earnestness of purpose and interest in the subject. The descriptions of his original or improved methods are often admirable and illuminating. A number of experiments are described which are not found in the ordinary text-book. Among these may be mentioned especially experiments on the eyes, intratracheal insufflation, elaborate and newer methods of anesthesia, oncometric and other experiments on the spleen and other organs, methods for the study of esophageal, vesical and uterine contractions, and the author's *chef d'oeuvre*—his ingenious methods of studying pulmonary conditions, namely, pulmonary circulation, pulmonary pressure, and the contractions of bronchioles. Altogether, Jackson's "Pharmacology" is a unique and interesting work and will be found helpful by the pharmacologist, especially in the execution of some particular kind of work.

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APHIS IMMUNITY OF TEOSINTE-CORN HYBRIDS

Certain properties and functions are possessed by some plants and animals providing them exemption from disease. The use of the word disease as applied to plants is sometimes restricted to bacterial and fungous parasitism and its effects. It is also sometimes applied to disorders brought about by various forms of malnutrition, including attacks by insects and other low forms of animal life.

> When the favorable conditions of life are so seriously interfered with by any agency, so that the life of a part of a plant or of the whole plant is threatened, we recognise disease in that plant.

When a plant is able to repel such devastating forces, more or less completely, it is said to possess corresponding degrees of total immunity.

Plants and animals are also subject to depredatory attacks of small animal life, parasitic in nature, but not producing what is ordinarily conceded as organic disease. Certain individuals repel or resist such depredations and it seems proper to call this phenomenon immunity.

It is with a behavior belonging to the last-named category that this account is concerned. The appearance of an instance of total immunity of any kind in an economic plant or animal seems eligible to record, and especially when the immunizing factor is hereditary.

During the early summer of 1913 there were grown in a greenhouse four short rows of F_1 or first generation hybrid plants coming from seed produced by fecundating teosinte, *Euclanea mexicana* with pollen of yellow dent corn, *Zea indentata*.[1] In the same bed, and immediately adjoining the hybrid rows, were grown one row of the parent strain of teosinte on the one side and four rows of the parent strain of corn on the other.

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[1] Teosinte and corn are both members of the grass family, but are classed in different genera. They hybridize freely with each other, although the teosinte is decidedly grasslike in appearance producing small two-rowed fruiting spikes in marked contrast to ears of dent corn. The first hybrid generation is intermediate in structure between the two parents, but more nearly resembling the teosinte in tillering profusely and being tall, slender and foliaceous. The hybrid ears are also small, fitting rigidly into a cavity of an internode of the rachis which disjoints readily at maturity, but succeeding generations produce some larger fruiting spikes more like the dent-corn parent.

As the spring season advanced several species of ants began visiting this bed. Later, colonies of aphis were found upon the roots of the corn, and finally heavy infestations upon the upper parts of a number of the corn plants. During four months of almost daily scrutiny no aphis was ever discovered upon either the teosinte or the hybrids. Ants were noticed occasionally upon these plants but their visits were apparently fruitless. A dozen or more hills of teosinte had been grown in 1909 and again in 1910 in cornfields heavily infested with aphis, but none had been noticed on the teosinte, although no particular attention was given to this question at the time.

The colonies of aphis in the greenhouse were sprayed effectively at intervals, but new colonies again appeared on the corn. It is well known that corn plant aphis, when not in the winged state of metamorphosis, frequently depend upon ants for transportation over short distances, *e. g.*, from one plant to a neighboring plant, as well as from one region to another on the same plant. The ants act as herders and protectors of the aphis, taking their toll in the sweet sticky fluid secreted by the aphis. The aphis are moved to a new feeding spot or pasture when the supply of fluid is not satisfactory to their herders.

The occasional appearance of ants searching over the teosinte and hybrid plants, indicated that the ants undoubtedly were willing and perhaps did perform their share of the compact, and that the aphis were unable to subsist upon the tissue of these host plants. Aphis in the winged stage, probably, lodged many times upon the immune plants.

It was learned that there were two recognizd forms of aphis involved in the problem, namely, the corn root-aphis, *Aphis maidiradicis,* and the corn plant-aphis, *Aphis maidis;* one working only or almost entirely on the roots and the other on the culm of the corn plant. The former is more numerous and destructive in corn fields.

The attacks of the sap-sucking aphids do not produce disease other than depleted plant tissue and local lesion in the area upon which they are at work. A portion of the insect secretions is waste—popularly known as "honeydew"—and produces the characteristic sticky, gummed and soiled surface where the aphis and the ants have been operating.

Just as there is no important grape-growing region free from the devastating woolly aphis or phylloxera of the vine; so, also, there is probably no corn-growing region of importance, in North America at least, which is free from the root-aphis of corn. There is no way of estimating accurately the enormous loss in reduction of yield caused by these insects which are steadily increasing in numbers and extent of migration, but this loss is known to be very great indeed. In Central Illinois the damage by the corn root-aphis sometimes causes total failure of the crop in limited areas.

Careful cultural methods may reduce considerably, for the time being, the number of aphis in a cornfield, yet the field may become reinfested from surrounding, untreated fields of corn and from other plants upon which the aphis are known to subsist.

Forbes reports finding from eleven to twenty-two generations of corn root-lice in one season. He estimates three hundred and nineteen billion lice and three trillion eggs left in the ground at the end of the season for each louse hatched in the spring. These figures are based upon the average rate of production with no undue break in the cycle.

> It is this high rate of multiplication by a number of successive generations which makes the root lice so destructive, even in fields first entered by a few winged lice borne on the wind from some neighboring field which has become more or less overstocked.

We may conclude that improved cultural methods and other common treatment will, at best, protect the cornfield only for a short interval. A more effectual remedy and permanent solution of the problem is to be welcomed. The amount of work connected with a thorough investigation of this discovery would have been far greater than the writer was able to undertake personally in connection with his other duties.

Perhaps in no one instance of reported resistance to disease and insect attack has the nature of the immunity been fully ascertained or circumscribed, although it is generally conceded as being highly desirable to determine the particular immunizing properties. In some cases it is thought to be due to hardiness of the individual, or vigor of growth; in others, to the durability, composition, or peculiarity of structure of the affected tissue.

In the plantlet stage of growth there is not much difference between the corn and the teosinte except that the leaves and stem of the latter are narrower and more slender. As the plants grow older the leaves of the teosinte are tougher and more leathery in texture, with pronounced teeth along the edges of the leaf. The corn leaves become slashed and torn to ribbons by wind storms, while the long narrow, and tough leaves of the teosinte remain entire. The sap of the corn plant is sweeter than the sap of the teosinte.

In the above-mentioned features the F_1 resembles the teosinte more than it does the corn. Since the aphis are sap suckers, the sweeter juice and more readily penetrated epidermis of the corn plant may be the deciding factors of immunity for the teosinte and the hybrid. This remarkable immunity apparently provided material upon insect parasitism as a means of determining genetic relationship and elucidation of the problem of inheritance of immunizing properties in plants.

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SPECIAL ARTICLES

THE TILLERING OF WHEAT

During the past eight years the writer has made a rather extended study of the tillering of winter wheat. The factors studied may be divided into two general classes, viz., heredity and environment. It has been found that the tendency to tiller appears to be largely a varietal characteristic. In order to study the behavior of the wheat plant with respect to tillering it was found necessary to plant the kernels in hills 6 by 6 in. apart. Two kernels were planted and later the plants thinned to one per hill. This method of seeding allowed the plant sufficient space to express rather fully its tendency to tiller. Seedings were also made by drilling in rows as is usually done in practical wheat culture. In this case, however, the number of tillers per plant could not be so accurately determined at harvest owing to the crowded condition of the plants in the row. As the plants came up the number was determined for a definite length of drill row. At harvest the total number of culms within this space was noted and divided by the number of plants. This gave the average number of tillers per plant. Where the wheat was seeded in hills each plant was cut separately and the culms counted. The mean for each variety was then determined by dividing the total number of culms by the number of plants. More than 150 varieties and strains of winter wheat were included in these tests. It was noted that the bearded wheats as a class seem to tiller more freely than the smooth. In order to test this characteristic of varieties more thoroughly identical varieties were grown the same season on both fertilized and untreated soil. All of the experiments were conducted in the field. The following table gives the average number of tillers per plant for four varieties of wheat, two smooth and two bearded.

TABLE I

Number of Tillers per Plant of Four Varieties Grown under Different Conditions

Test No.	Smooth		Bearded	
	Red Wave	Invincible	Red Wonder	Mediterranean
1	5.13	4.74	6.19	7 95
2	5 05	4.13	6.73	6 72
3	5.45	6 24	8 81	8 90
4	3 39	4 04	5.58	6.68
5	7.10	6.28	8.58	9.39
6	2 94	2 78	4.02	4.44
7	4 08	4.81	6 33	7.16
8	2 20	2 73	3.15	4.63
9	1.09	1.22	1.77	1.92
10	1 02	.98	1.29	1.45
11	.98	.97	1.06	1.20
12	1.14	2.04	2.95	2.63
13	1.01	1.07	1.81	1 69
14	1 01	1.19	1.46	1.39

As indicated in the table these varieties were grown under 14 different conditions, covering a period of eight years. In tests one to eight inclusive the varieties were grown individually by the hill method, while in the remainder of the tests the grain was grown in drill row. It will be noted from Table I. that the bearded varieties have produced more tillers per plant in every case.

In Table II. is given the summary of the results with all varieties included in the different tests on tillering. The number of varieties together with their repetition in the 13 different tests amounts to 973 cases. For the sake of convenience the ten highest and the ten lowest tillering varieties in each test are separated into a smooth and a bearded group.

TABLE II

Summary of Variety Test on Tillering showing the Proportion of Bearded and Smooth Varieties in the Highest and the Ten in Each Test

Test No.	No of Varieties			Highest Ten		Lowest Ten		No of Tillers per Plant	
	Total	Bearded	Smooth	Bearded	Smooth	Bearded	Smooth	Bearded	Smooth
1	84	51	33	10	0	1	9	1 37	1 12
2	76	37	39	9	1	2	8	2 15	1 05
3	57	25	32	8	2	0	10	1 26	1 11
3–a	57	25	32	7	3	1	9	1 08	1 01
4	67	31	36	9	1	2	8	7 70	6 02
5	58	29	29	9	1	3	7	3 21	2 85
5–a	58	29	29	8	2	3	7	1 68	1 46
5–b	58	29	29	9	1	4	6	1 10	1 06
6	113	60	53	10	0	2	8	1.40	1 23
6–a	113	60	53	9	1	2	8	1 18	1 04
7	53	25	28	7	3	1	0	1 28	1.13
8	80	42	38	7	3	1	9	2 95	2.50
8–a	80	42	38	9	1	2	8	1 63	1 35
Total				111	19	24	106		
Per Cent				85	15	20	80		

The number of tillers per plant refers to the average for all bearded and all smooth included in each test. It will be seen that the larger proportion of the high tillering varieties in every test is bearded while the greater number of the low tillering varieties is smooth. Of the 130 cases of the ten highest tillering varieties, 111, or 85 per cent., are bearded; of the 130 cases of the ten lowest tillering varieties, 106, or 80 per cent., are smooth. The results of these tests indicate that the bearded varieties have a greater capacity for tillering than the smooth.

In the study of environmental factors it was found that the rate of seeding a space per plant has a marked influence on the number of tillers produced per plant. Close seeding resulted in a smaller number of tillers per plant, earlier maturity and a better quality of kernel than wide seeding. The time of seeding determines to a large extent the rate of tillering. Early seeding is accompanied by a larger number of tillers per plant than late seeding. The time of seeding, the number of tillers per plant, the yield per plant and the quality of grain are closely correlated. The competition between plants induced by heavy seeding is more marked among smooth wheats than among the bearded. It appears that heavy seeding has a greater effect in lessening the number of tillers, the length of culm, spike, and yield of grain in smooth wheats than in bearded. The fertility of the soil is a factor that directly affects the rate of tillering. Nitrogen and phosphoric acid seem to stimulate the production of tillers; potash has little or no effect. The relation of tillering to yield is shown by the increase in the yield per spike as the number of tillers per plant increases to 4 or 5, beyond this the yield per spike is more or less uniform. The low tillering plants of a variety produce a smaller yield per spike, and the grain is of poorer quality. These experiments have shown quantitatively the effects on the rate of tillering of such factors as time and rate of seeding, the kinds of fertilizer and the relation of the number of tillers per plant to other characters. The tendency of bearded wheats to tiller more freely than the smooth has not been brought before to the attention of the wheat grower. A close analysis of these results indicates that there is a physiological difference between the two types of wheat which may mean that the bearded sorts are able to make better use of the plant food supplied or are able to extract it from the soil more easily than the smooth type of grain.

A. E. Grantham

Delaware Agricultural Exp. Station

A MEANS OF TRANSMITTING THE FOWL NEMATODE, HETERAKIS PAPILLOSA BLOCH[1]

A recent experiment demonstrated that the fowl nematode, *Heterakis papillosa* Bloch[2] may be transmitted to chickens by the feeding of a dung earthworm, *Helodrilus gieseleri hempeli* Smith.[3] The thirteen fowls (three of them controls) used in the experiment were hatched in an incubator, reared in a worm-proof field cage,[4] and given food free from animal tissues, while the dung earthworms were taken from a poultry yard in which the fowls were heavily infected with *H. papillosa*. When these chicks were about five weeks old, they were given dung earthworms every few days until each chick had ingested approximately forty worms. Of ten chicks so fed, four became infected with *H. papillosa*, the results of these examinations being as follows:

Chick 104, examined sixty-four days after first feeding, nine nematodes in the cæca.

Chick 117, examined one hundred thirty-seven days after first feeding, one nematode in the right cæcum.

Chick 128A, examined twenty-nine days after feeding, two nematodes in the cæca.

Chick 130A, examined twenty-seven days after feeding, two nematodes in the cæca. The six remaining chicks and the three controls were free from nematodes.

As is well known, these small nematodes commonly occur in the cæca of fowls, although they are not infrequently found in the large intestine. Of three hundred ninety-five chickens taken locally and examined in this laboratory during the last three years, two hundred ninety-three (74.1 per cent.) were infected with *H. papillosa*. The average infection was 34.4 nematodes, but a single infection of one hundred nematodes is not uncommon, and in one instance a fowl contained three hundred twenty-six of these parasites.

The means by which chickens become infected with *H. papillosa* is not wholly understood. Evidently, in some cases, a dung earthworm transmits these nematodes, but whether the relation between the two worms is one of parasitism or merely that of an association has not been fully determined. The presence of certain nematodes both free in the nephridia and imbedded in the muscles of earthworms furnishes a suggestive hypothesis. Dung earthworms are of common occurrence in the local poultry yards, and it might be possible to account for the rather heavy nematode infection of fowls from this source alone. But Leuckart long ago pointed out that *H. papillosa* may develop directly, according to Railliet and Lucet,[5] who, by feeding to a fowl eggs removed from the uterus of *H. papillosa*, secured a direct infection of fifteen of these nematodes. The writer, likewise, has obtained direct infections by giving eggs of this nematode to fowls reared under controlled conditions. These data indicate that the relation of the nematode to the earthworm is that of an association, in which case the eggs of the former might be carried on the slimy surface of the earthworm or in its engulfed food. However, the evidence is not such as to preclude the possibility that this earthworm, *H. gieseleri hempeli*, may, in some way, serve as an intermediate host of *H. papillosa*, and it is hoped that experiments now under way will reveal the nature of this relation.

James E. Ackert

Manhattan, Kans.

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[1] Contribution No. 19 from the Zoological Laboratory, Kansas State Agricultural College. Aid of Adams Fund.

[2] The identification of this nematode has been verified by Dr. B. H. Ransom, Zoologist, B. A. I., U. S. Dept. Agr., Washington, D. C.

[3] The earthworms were identified by Professor Frank Smith, University of Illinois.

[4] The field cage with its floor and eighteen-inch walls of cement is so constructed as to be practically insect-proof also. Examinations of control chickens every few weeks for three years have not yielded a single parasitic worm.

[5] Railliet, A., et Lucet, A., "Observations et expériences sur quelques helminths du genre *Heterakis* Dujardin," *Bull. Soc. Zool. France*, Par., 17: 117–120, 1892.

SCIENCE

FRIDAY, OCTOBER 26, 1917

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THE SIGNIFICANCE OF MATHEMATICS[1]

SEVERAL circumstances combine to render peculiarly fitting a consideration at this time of the significance of mathematics. Of late we have heard much from real or alleged educators, tending to show a lack of appreciation on their part, if not on the part of the public, of the vital part which mathematics plays in the affairs of humanity. These attacks were beginning to receive some hearing in the educational world, on account of their reiteration and their vehemence, if not through intrinsic merit.

A counter influence of tremendous public force, whose import is as yet seen only by those most nearly interested, has now arisen through the existence of war and the necessities of war. To the layman, lately told by pedagogical orators that mathematics lacks useful application, the evident need of mathematical training on every hand now comes as a distinct surprise.

The attacks on mathematics, and the lay conception of the entire subject, centers naturally around elementary and secondary instruction. We ourselves, college teachers of mathematics, have commonly talked of current practise and of reforms, largely with respect to secondary education. The third influence which contributes toward the present situation and which may strongly affect its future development is the formation and the existence of this great association, which affords for the first time in the history of America an adequate forum for the discussion of the problems of collegiate instruction in mathematics.

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[1] Retiring Presidential Address, Mathematical Association of America, summer meeting, Cleveland, September 6, 1917.

As retiring president of the association, I know of no more fitting topic than that I have chosen. It vitally concerns us; it is bound up with the functions of this association; and the times in which we live seem to point forcibly toward its consideration. I shall attempt to outline to you my own views on the true significance of mathematics, and to sketch what I for one would be glad to see this association promote.

In speaking of the significance of mathematics, I understand that we mean not at all the baser material advantage to the individual student, not at all a narrow utilitarianism, but rather a comprehensive grasp of the usefulness of mathematics to society as a whole, to science, to engineering, to the nation. Any narrower view would be unworthy of us; any narrower demand by educators means a degraded view of the purposes of education in a democracy.

Especially under the stress of war, public attention may be secured for the real claim of mathematics as a public necessity, not only to be employed by a few specialists, but also to influence and to determine the conduct and the efficiency of thousands.

Thus a knowledge of trigonometry and of the trigonometric theorems of geometry is a prime requisite for the successful and efficient conduct of our armies, not only by a few engineers who are to make maps and to train artillery, but also for all officers to whom the lives of men are entrusted. Any one of these officers, cut off with his force, without a superior engineer at hand, may lose his position and the lives of his men if he is ignorant of the significance of these propositions. Ignorance at such a crisis would be next to treason; it would be incompetence.

Do we, in trigonometry, so bring out the significance of the fundamental ideas on right triangles that the officer who faces such a test will sense the possibility of finding a range, or estimating a distance, without help and without instruments or tables? Frankly I do not believe that we have been doing this, even in such a practical subject as trigonometry. We have been too often content, and too often solely seeking, even here, the knowledge of intricate formalisms, of formulas and rules and theorems, of operations done mechanically. Too often we have omitted, even here, to give insight into the rather obvious significance of these rules and formulas.

On the whole, however, trigonometry is the one subject in which some small measure of insight has usually been secured.

If I now turn to other topics of our curriculum, may I not name scores of equally vital topic, usually studied by our students, in which insight is rarely gained? Let me mention some such instances:

In algebra, as taught in colleges, among the topics always considered are fractional exponents, logarithms and arithmetic and geometric progression. To many, fractional exponents remain a pure formalism, learned by rote and unappreciated, connected neither with the other topics just mentioned nor with any realities of life. That fractional exponents occur in expressions for air-resistance (as in airplanes), in water resistance (as in measuring streamflow), in electricity (as in induction), would surprise most students who pass our courses. That these exponents are determinable and are determined by logarithms would surprise students and some teachers, even if the essential equivalence of exponents and logarithms is adequately emphasized. The idea of a compound interest law, namely, that one quantity may proceed in arithmetic progression as another related quantity proceeds in geometric progression, is ordinarily not brought out, nor is the fact that this same situation leads to a logarithmic law.

The omission of these and similar vital connections, both of mathematics to the exterior world and of one topic in mathematics to another, is directly responsible for the failure of algebra to reach the hearts of our students, and for the failure of the students to gain real insight into the significance of the subjects they so dully learn.

I shall not dwell long on any one topic, for I desire to emphasize the existence of significance for life and society in the entire range of mathematical courses, and I desire to call your attention to the failure—shall I not say *our* failure?—to bring to light that significance.

Let me turn to analytic geometry for another instance of our traditional blindness, if it be that—our sin, if it is not blindness. Here, as before, applications abound. Most of the results of scientific experiment to-day are known and are recorded not by algebraic formulas of traditional form, but solely by curves traced in our traditional style, showing graphically the functional relations between two or more interdependent variables. Laws of physics, of chemistry, of every quantitative science, expressed by such means abound. The effort of science may well be said to be to deduce from such graphical functions the corresponding laws in algebraic or formalistic form.

Yet to most students of analytic geometry, precisely the reverse view seems to be our aim. The significance of analytic geometry as a piece of scientific machinery is totally lost, and the subject sinks to the level of dubious value in the minds of our students and of half-informed educators. In the present emergency, popular conviction of the real significance of analytic geometry for society is being attained, and may be fostered, through the occurrence of just such graphical laws in the dynamics of airplanes, in artillery performance (ballistics) and in wireless telegraphy. Here as in general in science, most of our information on functions is now in graphical form, and the desire to express the function in equation form illustrates the fundamental demand of science, and the fundamental significance of analytic geometry.

That the calculus is regarded as dry and uninteresting by many students, and that its value is occasionally doubted, is the strongest proof possible that its significance is not grasped. Here the connection with realities is so easy and so abundant that it is actually a skillful feat to conceal the fact. Yet it is done. I know personally of courses in the calculus (and so may you) in which the pressure to obtain and to enforce memory of formal algebraic rules has resulted in absolute neglect of the idea that a derivative represents a rate of change! I know students whose whole conception of integration is the formalistic solution of integrals of set expression by devices whose complexity you well know. That an integral is indeed the limit of a summation, and that results of science may be reached through such summation is often nearly ignored and not at all appreciated. That the ideas of the calculus should fall so low as to consist mainly in formal differentiations and integrations of set expressions must indeed astound any one to whom the wonderful significance of the subject is at all known. Moreover, it must convince any liberally minded educator who takes our own courses as a true representation of mathematical values that even the calculus is of no importance for real life or for society.

I might proceed to other courses—differential equations as given by Forsyth, the theory of equations as by Burnside and Panton or as by even the most recent writers, the theory of function (without any hint of its manifold connections with physics), the calculus of variations (denatured, without a hint of its vast importance in mechanics and elsewhere), projective geometry (with no mention of descriptive geometry nor the representation of space forms).

In all these, tradition has been leading us as far astray as it has in those more elementary courses of the secondary school, which we are wont to criticize. Shall we not search our own house? Shall we not ask if our own collegiate and graduate courses in mathematics demonstrate to students the real significance of the theory they cover? Have we denatured each subject until insight is eliminated and only formalism and logical tricks remain?

So long as this blight remains, we must expect and we shall deserve public disdain and sincere doubt of our value to humanity.

It should be unnecessary for me to explain my own deep interest in the logical and cultural side of mathematics. Certainly I would be the last to belittle its great spiritual values. But this is for the specialist rather than for the usual student. Values to the world at large must be stated in terms of more concrete realities. Shall we hide the fact of the immense service of mathematics to society? To emphasize beauty and pleasure to the entire exclusion of the more convincing argument of benefit to mankind is as quixotic and short-sighted as is the corresponding formalization of our courses of instruction. To ignore the significance of our great subject is to spurn our birthright.

Let me then, in retiring from office in the association, leave with you the sincere hope that a part of the work of this association be to impress upon the public the great value of mathematics in its direct effects upon life and upon human society. To accomplish this end, a most effective means, and one ready to hand, is to bring out to our own students, not halfheartedly, but with vigor, not a few but all available facts that shed light on the real meaning of what we teach. Let this association be a focus from which such doctrine may emanate, a forum in which such views may be emphasized and detailed. Thus I to-day have mentioned to you a few samples of our neglect, in haste and by name only. Shall we not discuss among ourselves these and other means toward the end, other topics whose significance is commonly lost or neglected, other points of view that will increase insight, even if it be at the expense of a few formulas or theorems that we traditionally treasure.

To the same end, may I now emphasize what seems to me a great if not the greatest function of this association? In America, up to recent years, the beauty and interest centering in pure mathematics has so absorbed all mathematical talent that we have almost if not quite neglected that other phase of mathematics in which the significance of all we do is so self-evident: applied mathematics. This association has, through its journal and through its meetings, already demonstrated its willingness and its ability to foster mathematics of this type. On this side of mathematics, not only discussion of the mathematics taught or to be taught, but even research papers of high grade have had in the past no adequate means of exposition. The wonderful work of Gibbs was for this reason long buried in the obscure Connecticut Academy and mathematical advancement along the important lines that he laid down was delayed or wholly prevented. The great work of G. W. Hill, which included profound investigations on infinite determinants, was for the same reason unknown and unappreciated by many mathematicians in this country until near his death, and work by others along the lines he mapped out was discouraged and delayed. Thus American mathematics has suffered not only in reputation, through the suppression of what are perhaps the greatest American achievements in mathematics, but also in that encouragement necessary to the establishment of a strong school. The same may be said of the essentially mathematical researches of other men still living, whom I hesitate to name,[2] whose work is scattered through journals on general science, journals on astronomy, journals on life insurance, journals on engineering, and so forth.

Already there have been published by the *Monthly* articles of research on topics in insurance, on mathematical history, on mechanics, and on other applied branches of mathematics. In the first annual meeting, Professors Wilson and Webster presented their own studies on the mathematical theory of the dynamics of the air. At the last summer meeting Professors Huntington and Hoskins presented studies on the foundations of mechanics. Such work, though deserving of high praise, has long had no suitable center for exposition and for encouragement. This association has afforded a means for exposition, as within the field of mathematics in its broader meaning, of papers in applied branches of mathematics. I trust that we shall continue this policy, and that we shall no longer rule out of our circle in mathematics, those who find the problems of applied mathematics peculiarly attractive. It should be our aim to encourage them and their students; to hear their work and to print it; to listen to their counsel on the needs of our traditional mathematical courses, to learn from them ourselves to appreciate more keenly the significance of mathematics as a whole.

In both these ways—by reorganizing our own instruction under the auspices of this association, and by the recognition and encouragement of workers in the various fields of applied mathematics, we may, and I think we should, increase the appreciation of the significance of mathematics among our students, among the public and even among ourselves. Incidentally we shall have done a service, not only to the public, in the increased emphasis upon phases of mathematics of real public service, but also to the advancement of mathematics itself, in that a better insight into the significance of mathematics will prevent or nullify mistaken attacks on the subject as one of little public worth.

Such to my mind should be one function, if not the chief function of this association; the regeneration of a significant mathematics, the encouragement of workers in applied mathematics, and the effort to obtain recognition of the true public worth of mathematics in every phase.

E. R. Hedrick

University of Missouri

AN INSTITUTE FOR THE HISTORY OF SCIENCE AND CIVILIZATION

To the Editor of Science: The appeal concerning "an Institute for the history of science and civilization" published in Science, March 23—ill-timed as it was—has met with the most encouraging response. Two communications relating to it have been published in Science, June 22 and July 6,[1] and a great many more have been privately addressed to me. Most of them, however, lay so much stress on some special feature of our plan that I feel it necessary to state again, briefly, the fundamental idea that underlies it, lest the real purpose of the institute be lost sight of.

But let me say first of all that there is at least one point upon which an unanimous agreement seems to have been reached. The whole budget of letters which I have received from all over the country, points to the conclusion that there is already a wide-spread, though scattered interest in the history of science, and that it is high time to organize it and to devote to these studies at least as much attention as is given to the history of other aspects of human life. The wretchedness of present conditions will be best depicted by remarking that, whereas there are hundreds of scholars who earn a living by teaching general history, or the history of art, of literature, of religion, there is not yet in America a single chair exclusively devoted to the history of science! From my very extensive correspondence on this subject, I gather, however, that before long an irresistible pressure will fortunately put an end to this paradoxical situation.

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[2] One of the men I have in mind is in attendance at these meetings.

[1] *Cf.* also F. S. Marvin in the *Positivist Review*, London, June, 1917.

The purpose of the institute can only be accomplished if its activities be constantly inspired by a close coordination of the three following points of view.

There is first *the point of view of the historian*: The progress of mankind is a function of the development of science. Indeed science is the only process which is really cumulative; it is also the most international. Hence to give a true picture of the development of civilization, it must be focused on the evolution of scientific thought and practice.

Secondly, *the point of view of the scientist*: The evolution of science must be studied to better understand the interrelations of all its branches, and the principles and real signification of each of them. The elaboration of science into an organic whole implies such historical research. A continuous criticism of the foundations of science is equally necessary, lest it degenerate into empiricism or into a system of prejudices. This critical work is essentially of an historical nature. The point of view involved is splendidly illustrated in the works of Pierre Duhem and Ernst Mach.

Thirdly, *the point of view of the philosopher*, which could also be called *the encyclopædic point of view*, the philosopher whom I have in mind being of course a man highly trained in scientific thought and research, but whose interest is mainly a coordinating, a synthetic one. It is clear that the more science is specialized, the more it becomes complex and extensive—the more also do some kind of synthetic studies become necessary to preserve its organic unity and indeed its very existence. A work of this kind has been more or less successfully accomplished at different periods by such men as Aristotle, Thomas Aquinas, Kant, Comte, Cournot, Spencer. It needs must be undertaken over and over again, but it becomes increasingly difficult and is now perhaps beyond the grasp of any single man. It is not simply a matter of genius—such synthesis does not require more genius now than it did in the fourth century B.C.—but the initial stock of knowledge to be mastered is so much greater that the process of classification and assimilation previous to any new synthesis must be partly effected on a cooperative basis.[3]

I beg to repeat that the fundamental idea of the institute is to coordinate these three converging points of view; that is, to organize —for the first time—a systematic collaboration between scientist, historian and philosopher, and so to make the accomplishment of their highest task possible, despite the increasing wealth and intricacy of specialized knowledge. These points of view complete and balance each other. He who separates them simply proves that he has failed to understand the purpose that we try to accomplish.

One may object that the cooperative work which we are advocating is already possible now—without a new institute—and that our universities already bring together some of the men whose collaboration is needed. The objection, however, is not valid, because, even if the right men happen to belong to the same university, economic conditions will generally prevent them from devoting themselves entirely to an activity of great amplitude and duration which does not pay. Besides, we can not depend on such chance combinations: this synthetic work must be carried through in a systematic way, with sufficient completeness and thoroughness, extreme accuracy and reasonable speed.

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[3] This is especially true for all the historical material. The encyclopædist must take the whole past into account; yet, he has no time to pursue historical investigations.

Hence, I believe that the creation of such an institute—either as a department of an existing university or other institution, or independently—is the only practical way to make possible this intimate collaboration of historian, scientist and philosopher which is becoming more and more necessary. Moreover, the institute would also provide one of the most effective ways of preparing a much needed reorganization of our educational system, the internal vice of which is clearly proved by the ever recurring controversy "science versus the humanities." It is obvious that the importance of science in education can but increase, but this can not be safely done without introducing a little of the humanistic spirit—*i. e.*, essentially a historical and disinterested point of view—in our scientific and technical studies. There should not be any rivalry between scientific and humanistic studies, but only cooperation to a common end; more knowledge, beauty, justice. Now, the proposed Institute would become the natural center of this *New Humanism* for which I am pleading; it would train men imbued by this new ideal—not one easily made up of vague generalities, but an idealism constantly rejuvenated and checked by intimate contact with the best available knowledge and the most exacting scholarship. Its humanizing influence would soon be felt all over the country.

I think that I can say, without any impertinence, that one of the shortcomings of this country—one that may imperil the accomplishment of her higher destiny—is the relative scarcity of broad and accurate scholarship. This is partly caused by economic conditions discouraging disinterested studies, but it also is due to the absence of a congenial tradition. The institute would establish such a tradition.

The reader who is in sympathy with the purpose of the institute will find no difficulty in appreciating the interesting suggestions published in these columns by Mr. Bert Russell and Mr. Aksel G. S. Josephson.

Mr. Russell suggests (June 22) that to the activities of the institute be added the following: "the facilitation of prompt and reliable judgments upon all questions of novelty arising in connection with the administration of the patent laws, thereby aiding in the placing of the administration of such laws upon a secure scientific foundation."

There should be indeed as close and friendly a collaboration as possible between the institute and the Patent Office. But we must not forget that the collections of the Patent Office refer almost exclusively to the technical end of science—taking all in all, not the highest one (a scientist does not generally patent the original combination of instruments that have led him to a discovery). Besides they refer only to the most recent times.

It is noteworthy in this connection, that I have also received two other interesting communications insisting on the importance of the study of primitive science and suggesting therefore a closer collaboration with ethnographic museums. As a matter of fact, the institute should try to consider not simply the beginnings or the latest developments of science and technology, but the entire development. After all, in the whole evolution, it is impossible to point out one step forward which is more important than the others; each is indispensable and there is no common measure between them.

If the institute is to be associated with another institution, the most useful association would perhaps be one with a great museum, such as the U. S. National Museum, the American Museum of Natural History or the Harvard Museums. The objects of a museum can not be easily moved or duplicated, whereas it is not difficult to move or photograph books or manuscripts. Moreover, the eventual creation of a museum of science such as the *Conservatoire des Arts et Métiers* or the *Deutsches Museum,* would be easier and less expensive if the institute were already connected with another museum.

Mr. Aksel G. S. Josephson lays special stress (July 6) on the bibliographical activity of the institute. The historians of science should be grateful to him for the valuable bibliographical work which he has undertaken in their behalf, and I, for my part, am much in sympathy with most of what Mr. Josephson says.

Still, we must not forget that bibliography is not an end, but simply a means, a method. I am, of course, chiefly concerned, not with external bibliography such as is needed in libraries, but with internal, critical bibliography. From this point of view, it is quite clear that the matter of essential importance is not the mere bibliographical technique—however important it may be—but a deep knowledge of the subject matter to be criticized.

I am quite agreed with Mr. Josephson, that many scientists show a deplorable lack of bibliographical method. Yet, I do not think it possible, as a rule, to train bibliographers for very special critical work. Anyhow it should be easier to teach bibliographical consistency to the scientists, than to make the bibliographers omniscient.

I hope that Mr. Josephson will be pleased with the following conclusion. There should be on the staff of the Institute at least one highly trained bibliographer, whose duty it would be to distribute the books and articles among expert critics and to see to it that their work, as far as external bibliography is concerned, be as accurate and uniform as possible. His functions would chiefly be those of a bibliographical editor.

At the present time, excellent critical bibliographies are periodically published for almost all the branches of science, but there is none really satisfactory for their history, philosophy or for the organization of the whole. I had tried to organize such a bibliographical service in *Isis*, but unfortunately this publication was stopped by the war, just when I was beginning to see my way to do it well. The publication of such a bibliography would naturally be incumbent on the institute; considerable pains should be taken to make it as perfect as possible—but it would only be a means to a higher end.

George Sarton

Harvard University

THE MEDICAL SCHOOL OF THE UNIVERSITY OF PENNSYLVANIA AND WAR SERVICE[1]

The same splendid equipment and patriotism that enabled the graduates of Pennsylvania's medical school to take a preeminent position in the surgical and medical work of the Civil War, both in the north and south, promises to produce similar results in the present great war. It is too early to compile any trustworthy records of the great army of physicans and surgeons who are now in the service, but the lists grow longer every day.

Aside from what the medical alumni as a class are doing, the medical school as a whole is giving to the utmost of the skilled men on its faculty. Already between sixty and seventy members are in the government service, many of them occupying positions of the utmost importance. In fact, so many have gone that the teaching staff is maintaining its high standard only by the self-sacrificing effort of those who have remained.

Pennsylvania can take a pardonable pride in the fact that five of the base hospital units which have gone or are prepared to go from this city are under the direction of Pennsylvania men, while graduates of the University comprise most of their staffs. The University Base Hospital Unit No. 20, which has been ready to sail for several weeks, has Dr. J. B. Carnett for its director. Episcopal Base Hospital is under the direction of Dr. A. P. C. Ashurst. Dr. John H. Jopson occupies a similar position with the Presbyterian Base Hospital, while Dr. Robert Le-Conte, a member of the Board of Trustees, is director of the Naval Base Hospital No. 5 from the Methodist Hospital. Dr. Richard H. Harte is director of the Base Hospital No. 10, which the Pennsylvania Hospital sent to France last June.

In addition to the foregoing, Lieutenant Colonel Henry Page, '94 M., is commander of the Medical Training Camp at Fort Oglethorpe, Ga. On this staff are such men of national repute as Dean William Pepper, of the Medical School, and Dr. Alexander C. Abbott, while others have been sent to other camps.

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[1] From *Old Penn.*

Those members of the staff who are still on active duty at home are concentrating all their energies toward helping America to win the war. In addition to carrying on the regular work, a course in neurology and brain surgery is being given in the medical school under the direction of Dr. Charles Frazier.

About fifty officers of the Medical Reserve have been picked by the War Department to take this course preparatory to their assignment to duty either with the various training camps or in France. Dr. Frazier has charge of the course in clinical surgery. His assistants and the courses on which they are lecturing are: Dr. George Dorrance, anatomy; Dr. Theodore Weisenberg, physiology; Dr. S. D. Ludlam, pathology; Dr. George P. Mueller, operative surgery on the cadaver, and Dr. William G. Spiller, neurological diagnosis.

The officers taking this course come from all parts of the United States, Pennsylvania having been designated by the War Department as the particular institution to fit officers doing medical work along these lines.

It should be explained that there are several members of the medical school faculty who are doing very important government work, but still keeping up their work in the medical school. Among these may be mentioned Dr. Alonzo Taylor, professor of physiological chemistry; Dr. Richard M. Pearce, professor of research medicine, and Dr. Edward Martin, professor of surgery. Dr. Taylor, who performed important service for the State Department in Germany and France before our entry into the war, is now giving the government the benefit of his experience on the exportation of foodstuffs to neutral countries; Dr. Pearce is doing work for the Red Cross, while Dr. Martin is a member of the Council of National Defense. The following is a nearly complete list of those members of the medical school faculty who have been given leave of absence to serve the government:

Dr. Walter W. Cornell, instructor in osteology. Now stationed at Fort Benjamin Harrison, Ind.

Dr. Penn Gaskill Skillern, instructor in anatomy. In the Navy with rank of lieutenant.

Dr. J. Leon Herman, instructor in anatomy. Member of Navy Base Hospital No. 5 with rank of lieutenant.

Dr. Alexander C. Abbott, director of the department of hygiene and bacteriology. Now stationed at Fort Oglethorpe, Ga., with rank of major.

Dr. David H. Bergey, assistant professor of hygiene and bacteriology. Now stationed at Fort Oglethorpe, with rank of captain.

Dr. Robert A. Kelty, instructor in pathology. In the Army.

Dr. Baldwin H. Lucke, assistant instructor in pathology. In the Army with rank of first lieutenant.

Dr. John Speese, instructor in surgery and surgical pathology. In the Army with rank of first lieutenant.

Dr. Henry P. Brown, Jr., assistant instructor in surgical pathology. In the Army with rank of first lieutenant.

Dr. Alfred R. Allen, associate professor of neuropathology. In the Army with rank of major.

Dr. Samuel Leopold, instructor in neuro-pathology. In the Army.

Dr. William B. Cadwallader, instructor in neuropathology. In the Army.

Dr. M. Howard Fussell, professor of applied therapeutics. In service with the Tuberculosis Commission of the Army with rank of captain.

Dr. William Pepper, assistant professor of clinical pathology and dean of the medical school. Assigned to Fort Oglethorpe, Ga., in charge of one battalion with rank of major.

Dr. Albert P. Francine, associate professor of medicine. In Army with rank of captain.

Dr. J. H. Austin, associate in medicine. Assigned to the Rockefeller Institute with rank of first lieutenant.

Dr. G. G. Ross, instructor in surgery. Member of Naval Base Hospital No. 5 with rank of lieutenant. Ordered to France September 15.

Dr. D. B. Pfeiffer, instructor in surgery. Assigned to Fort Oglethorpe with rank of captain.

Dr. A. P. C. Ashurst, instructor in surgery. Director of Episcopal Base Hospital Unit with rank of major.

Dr. E. L. Eliason. Member of University Base Hospital Unit No. 20 with rank of major.

Dr. George M. Laws, instructor in surgery. Member of University Base Hospital Unit No. 20. Now on duty at Fort Hancock, Augusta, Ga., with rank of first lieutenant.

Dr. Thomson F. Edwards, assistant instructor in surgery. In Army.

Dr. Rutherford L. John, assistant instructor in surgery. In Army.

Dr. Henry Winsor, assistant instructor in operative surgery. Captain in Sanitary Detachment of Second Battalion Signal Corps, Camp Jackson, Columbia, S. C., with rank of captain.

Dr. Allan C. Woods, assistant professor of research medicine. Now on duty in France with Base Hospital No. 10 with rank of captain.

Dr. De Forrest P. Willard, instructor of orthopedic surgery. Now at Shepherd's Bush Hospital, London, Eng., with rank of captain.

Dr. F. E. Keene, instructor in gynecology. Member of University Base Hospital Unit No. 20 with rank of first lieutenant.

Dr. F. C. Knowles, instructor in dermatology. In France with Base Hospital No. 10 with rank of first lieutenant.

Dr. E. H. Goodman, associate in medicine. Assigned to Base Hospital at Greenville, S. C., with rank of major.

Dr. G. M. Piersol, associate in medicine. In Army with rank of major.

Dr. J. H. Musser, associate in medicine. In Army with rank of first lieutenant.

Dr. C. B. Farr, associate in medicine. Assigned to Fort Oglethorpe with rank of first lieutenant.

Dr. E. B. Krumbhaar, associate in medicine. In Army.

Dr. J. H. Cruice, instructor in medicine. In Army.

Dr. Ward Brinton, instructor in medicine. In Army.

Dr. N. B. Gwyn, instructor in medicine. With British Army Medical Corps.

Dr. A. H. Gerhard, instructor in medicine. In Army.

Dr. T. G. Schnabel, instructor in medicine. In Army.

Dr. H. B. Wilmer, assistant instructor in medicine. In Army with rank of first lieutenant.

Dr. George Wilson, assistant instructor in medicine. In Army with rank of first lieutenant.

Dr. Herbert Fox, director of Pepper Clinical Laboratory. In Army, assigned to Louisville, Ky.

Dr. J. E. Sweet, assistant professor of surgical research. In France with Base Hospital No. 10 with rank of captain.

Dr. Richard H. Harte, adjunct professor of surgery. Director of Base Hospital No. 10, now in France with rank of major.

Dr. John H. Jopson, associate in surgery. Director of Presbyterian Base Hospital with rank of major.

Dr. J. B. Carnett, associate in surgery. Director of University Base Hospital Unit No. 20 with rank of major.

Dr. George E. de Schweinitz, professor of ophthalmology. On duty in General Medical Board and Commission of Ophthalmology in Council of National Defense, at Washington, with rank of major.

Dr. H. Maxwell Langdon, instructor in ophthalmology. Now on duty at University Hospital examining candidates for Aviation Corps with rank of first lieutenant.

Dr. Philip F. Williams, instructor in obstetrics. Member of University Base Hospital Unit. Now at Fort Oglethorpe with rank of captain.

Dr. Edmund J. Piper, instructor in obstetrics. In Army with rank of first lieutenant.

Dr. Benjamin D. Parrish, instructor in otology. In Army.

Dr. James A. Babbitt, instructor in otology. Now with Haverford College Unit in France.

Dr. Isaac H. Jones, instructor in Otology. In Army with rank of major.

Dr. Warren Stirling, assistant in bacteriology. Now stationed at Fort Benjamin Harrison with rank of first lieutenant.

Dr. Andrew Anders, lecturer in medicine. Ordered to Fort Oglethorpe, Ga., with rank of first lieutenant.

Dr. Stilwell C. Burns, instructor in surgery. Now on duty at Spartanburg, S. C., with rank of captain.

Dr. W. Easterly Ashton, professor of gynecology. Assigned to 300th Heavy Artillery with rank of major.

Dr. John W. McGlenn, assistant professor of obstetrics. In charge of Naval Station Hospital No. 2 at League Island with rank of first lieutenant.

Dr. Charles B. Reynolds, assistant professor of obstetrics. First lieutenant 309th Infantry.

SCIENTIFIC EVENTS

THE TOTAL ECLIPSE OF THE SUN IN 1918

THE department of astronomy and astrophysics at the University of Chicago is making preparation for observing the total eclipse of the sun, which will be one of the six to occur in the United States during the present century. This total eclipse will be visible on June 8, 1918, over a narrow strip having a maximum width of about sixty miles and extending from the state of Washington through parts of Oregon, Wyoming, and Idaho, across Colorado and Kansas, and finally reaching Florida about sunset. The duration of totality will be two minutes and two seconds at the coast of Washington, and less than half that time in Florida.

Director Edwin Brant Frost, of the Yerkes Observatory, and his colleague, Professor Edward Emerson Barnard, astronomer at the observatory, recently spent a week in Denver, where the authorities of the University of Denver have placed their facilities at the disposal of the party from the University of Chicago, through the courtesy of Professor Herbert A. Howe, who is himself a graduate of the Old University of Chicago. Among the various pieces of equipment at the Yerkes Observatory is apparatus which could be suitably adapted to the excellent 20-inch equatorial of the Denver University. It was necessary to know whether this equatorial could be successfully used as a photographic instrument, and Professors Frost and Barnard were finally successful in demonstrating that it could be. It will accordingly probably be used with a spectroscope from the Yerkes Observatory for photographing the spectrum of the corona, and, if possible, for measuring its speed of rotation.

From a considerable study of the weather observations and from estimates of cloudiness in June made for several years by volunteers along the path of the shadow, it appeared that certain regions in the mountains of Colorado were likely to be cloudy in the afternoon. This applies also to Denver. Accordingly a side trip was made by Director Frost to Green River, Wyoming, a point on the Union Pacific Railway, lying between Cheyenne and Ogden. This station is situated in the so-called Red Desert, with a rainfall of about ten inches per year and at an elevation of 6,000 feet. A suitable station near the town was readily selected and the transparency of the air was extraordinary on the day spent there. This station seems one of the most promising of any along the line of totality.

However, a small cloud may spoil the preparations of many months, and therefore another site was selected about sixty miles southeast of Denver on the Rock Island Railway, near Matheson, Colorado, at an elevation of about 6,000 feet. The trip was made by Director Frost from Colorado Springs with several members of the faculty of Colorado College. This site is a very favorable one and quite likely to be free from clouds in the afternoon. It is not the present plan to have members of the party from the Yerkes Observatory at this point, although minor instruments may be sent there for use by others. The station at Green River, Wyoming, will be the principal station for the party from the University of Chicago, if, as is hoped, the university is able to supply the funds for observing the eclipse in an adequate way.

The only previous expedition from the Yerkes Observatory for observing a solar eclipse was in 1900, to Wadesboro, North Carolina, where the total eclipse on May 28 was observed with very satisfactory results by a considerable party from the observatory.

THE MARIA MITCHELL MEMORIAL FELLOWSHIP OF THE HARVARD OBSERVATORY

The Maria Mitchell Memorial Fellowship of the Harvard Observatory, of the value of $500, is offered to a woman for the year beginning September 15, 1918. A competitive examination will not be held. The candidate must present evidence of qualifications under the following heads:

1. A letter from the candidate addressed to the secretary of the committee, giving an account of previous educational opportunities and training, and of plans for future work.
2. College diploma or a certificate from the registrar of her college, and if she has already held a position as instructor or teacher in any college or other institution, a clear statement of the work done, together with a certificate as to the quality of work.
3. Examples of work already accomplished.
4. Testimonials as to ability and character.
5. Satisfactory evidence of thoroughly good health.

The fellowship at all times must be used for purposes of serious study, and the fellow should be as free as possible from other responsibilities.

Applications for the year beginning September 15, 1918, should be made under the above heads, and must be in the hands of the secretary of the committee, Mrs. Charles S. Hinchman, 3635 Chestnut Street, Philadelphia, Pennsylvania, on or before April 1, 1918.

Professor Mary W. Whitney,
director emeritus of Vassar College Observatory, *honorary chairman*,
Annie J. Cannon, A.M.,
curator of astronomical photographs, Harvard College Observatory, *chairman*,
Professor Edward C. Pickering, Sc.D.,
director of Harvard College Observatory,
Professor Anne S. Young, Ph.D.,
director of Mt. Holyoke Observatory,
Professor John C. Duncan, Ph.D.,
director of Whitin Observatory, Wellesley, Mass,
Elizabeth R. Coffin, A.B.,
Vassar College, 1870 Nantucket, Mass.,
Florence M. Cushing, A.B.,
Vassar College, 1874, Boston,
Lydia S. Hinchman,
secretary, 3635 Chestnut Street, Philadelphia,
Committee

AN AMERICAN HOSPITAL IN LONDON

The United States Ambassador, who was accompanied by Mrs. Page, recently opened St. Katherine's Lodge, Regent's Park, as a hospital for American and British officers.

The house, in the Outer Circle, Regent's Park, with grounds of about four acres, has been equipped for about 40 patients by Mr. and Mrs. William Salomon, of New York, owners of the lease, who will maintain it for the duration of the war. It is controlled by the London Chapter of the American Red Cross, and is the first American Red Cross Hospital established in Europe. It is fitted to accommodate orthopædic cases. The United States War Department recruited 20 of the most prominent orthopædic surgeons in the United States and sent them to England under the command of Major Goldthwait, of Boston. Two of these surgeons, who are attached to the Shepherd's Bush Military Orthopædic Hospital, Captain F. Kidner, of Detroit, and Captain de Forrest Willard, of Philadelphia, have been chosen as the nucleus of the medical unit at St. Katherine's Lodge, under the general supervision of Colonel Sir Robert Jones. It is hoped that both British and American officers will be treated at the hospital throughout the war. The nursing staff will be American.

For work other than orthopædic the following London physicians and surgeons have offered their services on the staff.

Colonel Donald Armour, Dr. A. P. Beddard, Sir James Mackenzie Davidson, Dr. H. J. Banks Davis, Dr. Guy Leroy Gillett, Captain Charles T. W. Hirsch, Mr. Herbert Parsons, Mr. F. J. Pearce, Dr. George Pernet, Dr. Hugh R. Phillips, Surgeon-General Sir G. H. Makins and Lieutenant-Colonel Hugh M. Rigby.

The following are members of a committee of control:

Viscountess Harcourt, Mrs. Walter Hines Page, Mrs. Whitelaw Reid, Mrs. L. P. Sheldon, Mrs. William Salomon, Mrs. L. P. Sheldon, Mr. William Salomon, Colonel Sir Walter Lawrence (representing the British War Office) and Mr. L. P. Sheldon (chairman).

Among others present yesterday were Sir A. Keogh, Surgeon-General Sir G. H. Makins, General Nassiter, and Commander Badcock (representing Admiral Sims).

Mr. Page said he had to acknowledge the great generosity of the donors and the successful work of Mr. and Mrs. Sheldon and the American Red Cross. It was gratifying to find the work well started in London, and the organization already making itself useful. The hospital differed from others in that it would give orthopædic treatment to officers. He was told that 70 per cent. of cases yielded to the treatment which had been developed under the leadership of Sir Robert Jones.

SCIENTIFIC NOTES AND NEWS

Dr. William R. Blair, of the University of Chicago, has been placed in charge of the meteorological service of the Signal Corps, which includes a very extensive program for mapping the highways of the upper air.

Dean James R. Angell, of the department of psychology at the University of Chicago, has been relieved from his university duties and has gone to Washington to work in the offices of the National Research Council.

Professor A. D. Wilson, of the University of Minnesota, and chairman of the Minnesota Food Production Committee has been appointed food administrator for Minnesota.

Mr. Warren R. Schoonover, instructor in soil biology in the department of agronomy, University of Illinois College of Agriculture, and Agricultural Experiment Station, recently enlisted in the Gas Defense Service of the Sanitary Corps, United States Army. He expects to be connected with the Over-seas Repair Section, No. 1.

Dr. Thomas McCrae, professor of medicine in Jefferson Medical College, who has been in charge of a large military hospital in England, has returned home and resumed his practice and teaching in Jefferson College and Hospital.

Frederick D. Fuller, formerly chief deputy state chemist of Indiana, and more recently in charge of the scientific and educational department of the American Feed Manufacturers' Association, has accepted the appointment as chief of the Division of Feed Control Service, Texas Agricultural Experiment Station, College Station, Texas.

Dr. Philip Castleman has been appointed deputy health commissioner of Boston, and Dr. Honore Van de Velde, assistant director of pathologic laboratories in the health department. Dr. M. Victor Safford, of the Public Health Service, has been appointed epidemiologist of the Boston Health Department.

Professor W. L. Oswald, head of the seed laboratory of the University of Minnesota, was made secretary of the association of official seed analysts of North America at a convention held at Detroit, Mich., June 19, 20 and 21.

The College of Physicians of Philadelphia announces that the Alvarenga Prize for 1917 has been awarded to Dr. Wilbur C. Davison, Baltimore, for his essay entitled "The Superiority of Inoculations with Mixed Triple Vaccine over successive inoculations with the single vaccines, as shown by Agglutinin Curves in Men and Rabbits."

Dr. W. J. Holland, director of the Carnegie Museum, Pittsburgh, has received a telegram from St. John's, N. F., announcing the arrival at that point of the expedition which last April started from the Bay of Seven Islands on the Gulf of St. Lawrence for Ungava, on Davis strait, the expedition having succeeded in its object of crossing the peninsula of Labrador from the south to the north. The expedition was financed jointly by the Carnegie Museum, the National Geographic Society and Alfred Marshall, of Chicago, who was a member of the party. With Mr. Marshall were W. E. C. Todd, the curator of ornithology in the Carnegie Museum, and O. J. Murie, the curator of mammals in the same institution. They took with them a number of Indians. A number of unsuccessful attempts have been made previously by explorers to cross Labrador from the south to the north.

Professor J. Paul Goode, of the department of geography at the University of Chicago, is to give an address on "Geographic Influences in the European War," before the Minnesota Educational Assocation, which meets in Minneapolis from October 31 to November 3.

Professor R. A. Budington, of Oberlin College, gave an address on Louis Pasteur and his work before the Men's Club of St. Andrews Episcopal Church at Elyria, O., on October 17.

Eugene T. Roeber, editor of the *Metallurgical and Chemical Engineer*, died on October 17 at his home in East Orange. He was born in Germany in 1867, and came to the United States in 1894. In 1902 he was one of the founders and first directors of the Electrochemical Society and continued a director until 1913, when he became president.

Dr. James A. Gibson, professor of anatomy in the University of Buffalo, and for the last seven years secretary of the medical department, died on October 4 at the age of fifty years.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of Isaac M. Seligman, brother of Professor Edwin R. A. Seligman, of the department of economics of Columbia University, who died on September 30, leaving an estate estimated at more than $15,000,000, the bulk of his estate is bequeathed to his family. He left bequests aggregating $69,000 to Columbia University, the Educational Alliance, Mt. Sinai Hospital, Society of Ethical Culture and other institutions.

Yale University's budget this year shows a net deficit of about $258,806 as a result of war conditions, it is announced, despite savings of about $200,000 mainly through decrease in the faculty salary list where members are absent in government service. The total registration this year was announced as 2,122, as against 3,262 last year, with a decrease of 117 university officers.

Student enrolment at Princeton University is 618 less than a year ago. The total registration is 937. A year ago it was 1,555. It is stated that for the first time since its organization the school of electrical engineering has no students.

The faculty changes at Stevens Institute of Technology this year include the appointment of former Assistant Professor Louis A. Hazeltine as acting professor of electrical engineering to fill the vacancy caused by the death of Professor Albert F. Ganz. Leslie H. Backer, M.E., has been appointed assistant professor in chemistry; Gustav G. Freygang, M.E., assistant professor in mechanics; Frank C. Stockwell, A.B., S.B., assistant professor in electrical engineering, and Lewis A. Belding, M.E., assistant professor in mechanical engineering. Extensive changes have been made in the addition and rearrangement of lecture and drafting rooms. The large building formerly occupied by the Stevens Preparatory School has been connected by a covered bridge with the main building, and has been renamed recitation hall. The interior has been rearranged to contain 15 lecture rooms and 14 offices, thus relieving the main building where a large drafting room has been created by removing partitions between old classrooms.

In coordinating the work between the main Texas Agricultural College and the two junior colleges, created by the last legislature, a representative has been assigned to the Vocational College at Arlington and to the Junior Agricultural College at Stephenville. Mr. J. A. Evans, pecan specialist, of the Extension Service, will be at Arlington, Texas, during the current year while Dr. Frederick H. Blodgett will be the representative at Stephenville.

Dr. Truman Michelson, of the Bureau of American Ethnology, has been appointed professor of ethnology in the George Washington University. He will also retain his position as ethnologist in the said bureau.

Dr. H. B. Goodrich and Dr. L. L Steele will conduct courses in the department of biology of Wesleyan University during the present year, or until a successor is chosen to the late Professor Herbert W. Conn.

Professor Ralph H. McKee, formerly of the University of Maine, and the past year in charge of the research department of the Tennessee Copper Company, has been appointed associate in chemical engineering at Columbia University. He will have in his especial charge the graduate work in applied organic chemistry.

Dr. Leon V. Hartman has been appointed professor of physics at the University of Nevada.

Dr. D. Walter Steckbeck has been appointed assistant professor of botany in the University of Pennsylvania.

Lee R. Dice, Ph.D., of the department of zoology of the Kansas State Agricultural College, has been given a temporary appointment as assistant professor of biology in the Montana State University, filling the place of A. W. L. Bray, who is taking advanced work at Harvard University this year.

W. F. Lusk, formerly of the department of rural education in the University of Minnesota, has accepted a position as professor of rural education in Cornell University.

Dr. Thomas Byrd Magath (Ph.D., Illinois) has been appointed instructor in anatomy in the medical college of the University of Illinois, Chicago.

DISCUSSION AND CORRESPONDENCE

REPLY TO DR. BLEILE

Dr. Bleile, in his reply[1] to my criticism of his paper on the "Rôle of Boyle's law in clinical sphygmomanometry,"[2] takes me to task, as I see it, on account of four scores.

The first is that I criticised an "abstract" of his paper. He does not make it clear that this "abstract" was written by himself and was published in the *American Journal of Physiology*. Nor does he make it clear that it has been abstracted in *Physiological Abstracts* in the form that is accorded to all papers. My criticism, therefore, is of statements that have been put on record in two publications.

The second count is personal: to this I will not reply.

The third count is that I "completely" missed the point of his paper. I take it that he here refers to my understanding of *his* statement of Boyle's law in comparison with *mine*, which, as I say in my criticism, led me "to suppose that in my application of Boyle's law I have committed the mistake of making the relation between pressure and volume a direct instead of an inverse one." If Dr. Bleile did not intend to give this impression, he had the opportunity of saying so in his reply; but on this subject he remains silent. This is to be regretted all the more, because *Physiological Abstracts* makes exactly the same interpretation as I made. The whole abstract[3] there consists of this sentence:

> It is shown that the oscillations of pressure and volume always vary inversely, as required by Boyle's law, and contrary to what is implied in Erlanger's hypothesis.

In the fourth count he accuses me of changing somewhat radically some of the statements of my own paper. If this accusation refers to my quotations, I can only say that they are absolutely verbatim. If it refers to my "paraphrase," I must leave it to others, who are sufficiently interested to take the time to compare it with the original, to decide whether the sense of my original statement is altered in it.

The major part of Dr. Bleile's "Reply" consists of a painstaking mathematical proof of the admission clearly made in my "Reply," that

> I inadvertently employed . . . the pressures taken directly from the mercury manometer instead of the absolute pressures.

He here, therefore, proves, as I say in my criticism, that "the failure to express the pressure in absolute terms affects . . . only the *magnitude* of the change, not its *sign*." And if the sign is not changed, my thesis is substantiated, for, to repeat,

> My only object in invoking Boyle's law was to show that under the particular set of ideal conditions premised . . . the amplitude of the pressure oscillations, resulting from the filling and emptying of the artery, must *increase* as the compressing pressure increases from the diastolic to close to the systolic level.

Since my criticism was written, Dr. Bleile's full report has appeared.[4] In it he makes additional criticisms of my work, which likewise are practically irrelevant to the purpose of my paper or are made possible through conditions gratuitously imposed. I will discuss one of these criticisms in order to indicate their nature. Dr. Bleile says:

> Erlanger's deductions are: If a pressure now equal to the diastolic be applied during the diastolic phase in the artery, no oscillations will be produced in the manometer during the pulsations of inside arterial pressure. For, he [Erlanger] argues, if the inside pressure rises above the dias-

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[1] Science, N. S., XLVI., 111, 1917.

[2] Science, N. S., XLV., 384, 1916.

[3] *Physiol. Abstr.*, II., 176.

[4] *Amer. Jour. Physiol.*, 1917, XLIII., 475.

tolic, the vessel is already completely filled, and being inextensible, can not expand further and therefore can not transmit the increase of inside or arterial pressure when it rises above the diastolic level. But I [Bleile] wish here to point out that if the pressure in the chamber is at the diastolic level and the pressure within the artery is also just at the diastolic level, then it does not at all follow that the artery must necessarily be filled with fluid. Since the artery is readily collapsible (though not elastic) it may be only partly filled, or it may be entirely flat and empty. It may be in any degree of fulness or emptiness. But one must know the amount of fluid within the artery before he can tell whether a rise in arterial pressure will be transmitted to the chamber. As a matter of fact, not unless the artery is completely filled with fluid at the diastolic pressure and the chamber pressure just equal to it is applied without allowing the artery to collapse the slightest amount, can the result obtained by Erlanger be possible.

In order to bring clearly before the reader the three sets of conditions described in the foregoing quoted paragraph, I analyze them here into the form of a table. In this table the numbers indicate the sequence of events. It thus is made obvious that Dr. Bleile's second set of conditions is merely a repetition of mine. And he admits that under his second set of conditions there will be no oscillations, which, it will be noted, is exactly the conclusion I came to. This result can be altered only by supplying energy not included in my premises. To be sure, no one can find any fault with the conclusion Dr. Bleile is led to by his first set of conditions, but they are not the set of conditions I chose to start with in developing the theory of compression oscillations.

Conditions	Initial Compressing Pressure	Initial Arterial Pressure	Compressing Pressure Increased to	Arterial Pressure Raised to	Resulting Compression Oscillation
Erlanger's.	Atmospheric (1)	Diastolic (2)	Diastolic (3)	Systolic (4)	None
Bleile's 1st.	Diastolic (1)	Diastolic (1)	No change	Systolic (2)	Any amplitude
Bleile's 2d.	Atmospheric (1)	Diastolic (2)	Diastolic (3)	Systolic (4)	None

Joseph Erlanger

Washington University Medical School,
St. Louis

THE CORRECT NAME FOR OUR APPLE-GRAIN APHIS

Much confusion has existed in regard to the name applied to our apple-grain aphis. In the first place the name *avenæ* which is now applied to this species in America was for many years applied to *Macrosiphum granaria*. These two species were eventually separated and *granaria* applied to the *Macrosiphum* on grains and grasses and the name *avenæ* restricted to the present species or group of species on the same plants.

To the apple-grain aphis on its primary host the name *mali* Fab. was applied. This name, *mali*, is, however, a synonym of *pomi* DeGeer, a species which was not well known in America. The alternation between grains and apple was worked out while the name *mali* was still in use for the species. When *pomi* became better known it was shown that the present species was not *mali*, *i. e.*, *pomi*, but was in reality the same species as the so-called *avenæ* on grains. *Pomi* was then restricted to the true *pomi* and *avenæ* transferred also to the apple-feeding form of this grain aphid.

Fitch described a species under the name *prunifoliæ* which he found upon the plum. In this description he gave the characters of some specimens collected and placed in his cabinet. These specimens are now in the National Museum collection and show that the species he had was the one treated in this note. Before publication, however, he observed some other specimens on plum and these had a black spot on the abdomen. He therefore included in his description remarks on this spot. His specimens, however, show that he really had the apple-grain aphis in his collection and in his manuscripts as *prunifoliæ*.

On account of his mentioning this spot subsequent writers considered his specimens to be specimens of *pruni* Koch. This latter species has been shown to migrate to thistles and in reality to be a synonym of *cardui* L. Therefore recent writers have considered Fitch's *pruni-*

folia to be a synonym of *cardui* L. His name, however, must be applied to the apple-grain species to which we are in this country giving the name *avenæ*.

In Europe it is known that the name *avenæ* is a synonym of *padi* L. and that the primary host of the oat aphis is the bird cherry from which it migrates to grains and grasses. *Avenæ* is, however, employed here for the species living upon the apple. To use the names correctly then *padi* L. should be applied to our apple-grain aphis. But this would not be correct, for *padi* winters on cherry and migrates to grass. It is evident that our species is not *padi*.

Fitch described a species on choke cherries under the name of *cerasifoliæ*. This species curls the leaves of the cherry and suggests the work of *padi* in Europe. Transfers made by the writer prove that this species alternates between chokecherry and grasses in the same way that *padi* migrates in Europe. It is not impossible that they are the same species. We have then to deal with this species also on grains and grasses in the *avenæ* mix up. It is noteworthy that the cornicles of the chokecherry species are sometimes slightly swollen in a way similar to those of the common oat aphis. The second fork of the wing is also very close to the margin of the wing and rusty patches are present at the base of the cornicles of the individuals feeding on grains and grasses.

Some authors have expressed the opinion that our apple-grain insect is biennial. The experiments conducted by W. F. Turner and the writer prove that it is annual. It is not improbable that the difficulty in transfer arose, in that more than one species was concerned and that the apple was in reality not the winter host of the specimens transferred.

From the evidence in hand it appears:

1. That more than one species occurs upon grains and grasses under the name *avenæ* Fab.
2. That one of these species migrates to apple and related trees where the eggs are laid. This species must be known as *prunifoliæ* Fitch.
3. That another species, the oat aphis, migrates to bird cherries in Europe and must be known as *padi* L., of which *avenæ* Fab. is a synonym.
4. That the species now known as *cerasifoliæ* Fitch migrates to grains and grasses as does *padi* and is possibly the same species.
5. That the present placing of the name *prunifoliæ* as a synonym of *cardui* L. is not correct.

A. C. Baker

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QUOTATIONS

COLUMBIA UNIVERSITY AND PROFESSOR CATTELL

I should think that the New York newspapers would be as tired of me as I am of them. As, however, you have devoted another editorial article to Columbia University and to my case, I beg permission to state certain facts.

My relations with the university were not considered by the department or faculty of which I was a member, or, contrary to your statement, by any faculty committee. At a meeting of the Columbia trustees on March 5 a resolution was introduced retiring me on account of a frivolous but truthful remark that I had made concerning the president of the university in a confidential letter to members of the Faculty Club. At the same meeting of the trustees a committee was appointed to ascertain whether doctrines contrary to the Constitution and the laws were being taught or disseminated at Columbia.

This latter resolution raised a storm of protest, the faculty of political science voting that it "betrays a profound misconception of the true function of a university in the advancement of learning." After passing resolutions of protest, the council, itself primarily an administrative body, appointed a committee of nine to defend the interests of academic freedom. This was not a committee of the faculty, but a Butler-Seligman committee, containing six deans, who are appointed by the president, and, according to the statutes of the university, must "act in subordination to the president." From this committee Professor

Dewey has recently resigned as a protest against the general situation.

The resolution retiring me was referred to the committee, which unanimously recommended that no action be taken. They, however, asked me for an apology for my ironical remark about the president, and I signed the statement which Professor Seligman wrote, on the assurance that this would be of great service to the committee in maintaining the rights of the faculty and of freedom of speech, and on the promise that it would be shown to no one except the committee on inquisition of the trustees, and only to them if necessary. When the apology was sent out by Professor Seligman to officers of the university and printed in the newspapers I wrote a letter to members of the Faculty Club telling how it had been obtained. I thought I owed this to them, as many had approved of my remark about the president, one professor, for example, having written: "Let me first of all thank you for saying so well some of the things that I and many others dare not say for fear our families would be left without support if we did say them."

Professor Seligman then wrote a letter to me, copies of which he sent out by the hundred, stating that I did not "respect the ordinary decencies of intercourse among gentlemen'' and that my "usefulness in the university has come to an end." As I understand it, Professor Seligman claims that he only broke the promise of a gentleman and I had no right to reveal the fact. I hold that it was the promise of the acting dean of the graduate faculties and of the chairman of the committee of nine of the council, made officially in the dean's office, and that secret diplomacy should have no place in a university.

Whatever may be the rights and wrongs of this petty squabble, seven of the nine members of the Butler-Seligman committee on June 18 recommended that I be retired from active service with the pension due me. The trustees, however, chose to dismiss me for maintaining academic freedom in the classical sense, not for resisting academic slavery as it exists at Columbia.

When they dismissed me on October 1, without a hearing, without payment for the year and without the pension due me, it was on the sole ground that I had on August 23 addressed a letter to members of the Congress asking them to support a measure then before the Senate and the House to prohibit sending conscripts "to fight in Europe against their will." There is no law requiring or permitting the President to send "conscientious objectors" to fight in Europe. To do this, according to an opinion prepared by the Attorney General of the United States for the President in 1912, would be unconstitutional. It is also against the uniform policy of the nation. It would provide a less efficient army and might cause disorder at home. The British government does not require "conscientious objectors" to fight, and does not force conscription on Ireland. I only exercised the constitutional right and fulfilled the duty of a citizen in petitioning the government to enact legislation which I believe to be in the interest of the nation. By a curious irony the committee of the trustees appointed to guard the Constitution recommended my dismissal for using the method which the Constitution states shall not be abridged in a letter written to members of the Congress asking them to respect the Constitution.

If the president and the trustees could have found in anything else that I have said or done anything that by any possible perversion could have been made to appear unpatriotic they would have been only too glad to have adduced it. As it is, they have hid behind the flag to assassinate, relying on the prejudice and blind patriotism of war. They might have retired me for insubordination, and there would have been no public protest; but they apparently wanted to injure me and discredit my efforts for university reform. This they may have been able to do, but only by causing at the same time far greater injury to the university.

I favor peace on the Russian terms, practically adopted by the President in his reply to the Pope. But both before and since our entry into the war I have done everything in my power to promote national efficiency. I spent a large part of the week before I was dismissed drawing up for the War Department plans for the scientific selection of aviators. My oldest son, with my approval and assistance, was one of the first to enlist in the army and go to France, where he is in charge of sanitation in the Harvard hospital recently bombed by German aviators.—J. McKeen Cattell in the New York *Tribune*.

SCIENTIFIC BOOKS

Algæ. Volume I. Myxophyceæ, Peridinieæ, Bacillarieæ, Chlorophyceæ, together with a Brief Summary of the Occurrence and Distribution of Freshwater Algæ. By G. S. West, M.A., D.Sc., A.R.C.S., F.L.S., Mason Professor of Botany in the University of Birmingham. Cambridge, The University Press, 1916. G. P. Putnam's Sons, New York. $7.50.

The first volume of the series, to be issued as the Cambridge Botanical Handbooks under the editorship of Professor A. C. Seward and A. G. Tansley, of the school of botany of Cambridge University, is Professor G. S. West's volume on the "Algæ." A life-long interest in, and an ever-increasing acquaintanceship with the extraordinarily diversified and numerous organisms embraced within the scope of this work have qualified this leading British algologist to undertake this task. For many years father (the late William West) and son have collaborated in the publication of a long series of memoirs and monographs dealing with the microscopic flora, not only of British waters, but of those of many other lands also. The critical knowledge thus acquired of the very large number of genera and species of algæ, mainly microscopic, has made possible this scholarly and well-proportioned treatise.

Dealing as it does with the Protophytes, the work is of especial interest, not only to botanists, but also to zoologists, especially protozoologists, who have long felt the need of a work more comprehensive in scope and succinct in treatment than Oltmann's "Algen," Chodat's "Algues Vertes de la Suisse," or the authors' "Treatise on the British Freshwater Algæ," and more critical, the Lemmermann's useful handbooks of the Brandenburg Algæ.

Professor West's work adequately supplies this need. Since the work includes the Dinoflagellata (Peridinieæ) and the Volvocidæ (Volvocineæ) flagellates familiar to all zoologists and prominent in our text-books, the reviewer takes this means to call the attention of all zoologists and of biologists generally to the mine of information contained in this work. He shares with the author the opinion that the Flagellata are a primitive group and therefore of exceptional significance to all who seek the beginnings of either the plant or the animal world, and especially to students of sex, reproduction, variation, and the processes of evolution. It is noteworthy that the classification of green algæ adopted by the author and the criteria of their chief subdivisions are based upon flagellate affinities.

It is perhaps natural that Profesor West's investigations of the Phytoplankton should have convinced him that most flagellates are holophytic and that ninety per cent. of the Dinoflagellata "are true vegetable organisms with a holophytic nutrition," but students of parasitic flagellates will demur from the first conclusion. In the reviewer's experience there is abundant evidence that the Gymnodinioidæ, or the most primitive section of the Dinoflagellata, the most abundant flagellates of the sea, are predominantly holozoic, and some are even cannibalistic, while many of the deep water species are undoubtedly saprophytic.

The author's conclusions regarding polymorphism among the algæ, especially the Chlorophyceæ, will interest all students of variation and evolution. Professor West has been a champion of the view of specific stability among the unicells, as over against the view of a wide polymorphism advocated by Chodat, Playfair and others. The results of the pure culture method in the hands of Klebs, Beijerinck, and others, have in the main supported the conclusion that specific stability is quite as constant among the algæ as it is among higher plants. It is doubtless true that much of the so-called evidence for polymorphism has rested upon misjudgment as to the relationships of convergent types commingled in a common environment and has no basis in critically conducted pure cultures. On the other hand, it is certainly to be expected that more instances of polymorphic life cycles, both obligatory and adaptive, will be discovered when the full histories of green unicells are unraveled. Furthermore, among the Dinoflagellata with certainty, and possibly among the desmids also, there is a high degree of self-regulating control of surface structures leading to a considerable range of form within the species. This is made evident from the fact that in both of these groups there are many species in which at the time of binary fission the daughter organisms each inherits one half of their exoskeleton or cell wall and forms the other half under the influence of the circumambient environment, which in some instances induces a strikingly different form of cell wall, involving structures utilized as specific characters. These may be of a mutative category, or more evidently of an adaptive or self-regulatory nature. It is also true that the theca or exoskeleton of the Dinoflagellata is subject to autotomy, local ecdysis, total exuviation, and local resorbtion and reconstruction to a considerable degree, after its formation, in adaptive response to changing environmental conditions. Such changes are not, however, of the same order of magnitude as those more profound ones occurring in the transformations in the life history of algæ, such as the *Palmella* stage of the Chlamydomonads.

On the whole, Professor West's contention as to specific stability seems to be well founded, provided adequate latitude for the metamorphoses of life history is retained and due allowance is made for adaptive and involution stages arising under environmental pressure. Both the pure culture method and wide observation of much material of the species under varying environments are needed to determine the normal range of form.

The rapid growth of biological literature in the past decades has tended to isolate botanists and zoologists, to the detriment of progress in both fields. Professor West's work is of great value in facilitating excursions of zoologists into one fundamental and suggestive field of botanical research.

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A German-English Dictionary for Chemists. By Austin M. Patterson, Ph.D., editor of chemical terms for "Webster's New International Dictionary" and formerly editor of "Chemical Abstracts." New York, John Wiley & Sons, Inc.; London, Chapman and Hall, Limited. 1917. Pp. xvi + 816. Price $2.00.

Dr. Patterson's dictionary fulfils a need which probably every English-speaking worker in chemistry has experienced, and fulfils it admirably. The large number of scientific and technical words and the abbreviations which puzzle the beginner in the reading of chemical German are all there and the older chemist long accustomed to the reading of German chemical literature will experience no less satisfaction in the use of this book, for it is sure to save him much time in determining the exact meaning of the words that even he is apt to find troublesome. The thoroughness with which the dictionary covers the broad field of chemistry as well as such related sciences as physics, mineralogy and pharmacy is very satisfying. Since its appearance in January it has been in constant use in the office of *Chemical Abstracts,* where translating work involving every phase of theoretical and applied chemistry is done and it has stood this test of completeness in such a way as to justify the confidence with which it is used. I say "justify" because, knowing the nature of Dr. Patterson's work on other things and having in mind his experience in handling chemical literature and in compiling the chemical vocabulary and other parts of the New International Dictionary, we expect much.

In his translations of German names of chemical compounds Dr. Patterson has used care to keep the nomenclature in accord with the best usage. The Introduction, which should be very helpful in several ways, includes interesting sections on inorganic and organic nomenclature. Many American chemists should read and heed the translating rules contained in these sections, for all too often German spellings, especially endings, are carried over into names used as English. At times this results in confusion. The new dictionary will tend to correct this bad practise, and it is hoped that it will help the cause of good chemical nomenclature in other ways.

Besides words from fields of science related to chemistry the dictionary contains a general vocabulary "to save the user the trouble of looking up the more common German words in a separate dictionary" and "because many general words have a technical, or at least a customary, chemical meaning," which "in a general work is often either absent or buried among other senses." The entries are all brief, few of them requiring more than a single line (two columns to the page). There are no long paragraphs of combinations, examples, etc., to wade through. The English equivalent usually sought by the scientist is given at once. These features add greatly to the convenience in use.

The use of small type (six point), which does not seem objectionable since one does not read a dictionary steadily, has made for compactness. The book will fit a large pocket. The work of the printer and binder (the cover is flexible) has been well done.

E. J. Crane

Ohio State University

SPECIAL ARTICLES

THE NATURE OF THE ULTIMATE MAGNETIC PARTICLE

It appears probable from various considerations that when a substance is magnetically saturated, the "molecular magnets" of which it is composed have their axes arranged parallel with the external magnetic field. On this assumption it is possible to investigate the validity of those theories, such as Bohr's which would explain the magnetic properties of an atom as due to electrons revolving about the atomic center in orbits all lying in the same plane.

It has been shown that the relative intensity of the different orders of an X-ray spectrum line depends upon the distance of the electrons from the middle planes of the atomic layers in the diffracting crystal.[1] Imagine X-rays to be reflected from the surface of a ferro-magnetic crystal composed of atoms of the type just described. When the crystal is unmagnetized the different atoms will have their electronic orbits distributed in all possible planes, so that on the average the electrons will be at an appreciable distance from the mid-planes of their atomic layers. If, however, the crystal is magnetically saturated perpendicular to the reflecting face of the crystal, the electronic orbits, being perpendicular to the magnetic axes of their atoms, will all lie parallel to the crystal face. The electrons will therefore now be *in* the mid-planes of the layers of atoms which are effective in producing the reflected beam. It can be shown that such a shift of the electrons must produce a very considerable increase in the intensity of the reflected beam of X-rays. On the other hand, if the crystal is magnetized parallel to the reflecting face, the turning of the orbits will carry the electrons farther, on the average, from the middle of their atomic layers, and a decrease in the intensity of reflection should result. Of course if the electrons are arranged isotropically in the atom, or if the atom is not rotated by a magnetic field, which would mean that it is the electron or the positive nucleus that is the ultimate magnetic particle, no such effect should be observed.

We have hunted in vain for such an effect on the intensity of the reflected beam of X-rays when the reflecting crystal is strongly magnetized. In our experiment a "null method" was employed. The ionization due to the beam of X-rays reflected from a crystal of magnetite was balanced against that due to a beam reflected from a crystal of rock-salt, so that a very small change in the relative intensity of either beam could be detected, while variations in the X-ray tube itself had little effect.

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[1] A. H. Compton, *Phys. Rev.*, 9, 29 (1917).

By means of an electromagnet with a laminated core the magnetite crystal was magnetically saturated, and then demagnetized with an alternating current. The effect of magnetization perpendicular to the plane of the crystal face was investigated for the first four orders. On account of mechanical difficulties the test was made only in the third order when the crystal was magnetized parallel to the reflecting surface. In no case was any change observed in the intensity of the reflected beam when the crystal was magnetized or demagnetized, though the method was sufficiently sensitive to detect a variation in the intensity of less than 1 per cent.

A direct calculation shows that a displacement of the atoms of 0.004 of the distance between the successive atomic layers is sufficient to cause 1 per cent. change in the intensity of the fourth order spectrum If there is any displacement of the atoms when a crystal is magnetized, it is therefore very small. This confirms the observation of K. T. Compton and E. A. Trousdale[2] that magnetization does not shift the atoms in a crystal sufficiently to change the general form of the space lattice in which they are arranged, and verifies their conclusion that the ultimate magnetic particle is not a group of atoms, such as the chemical molecule, but is the individual atom or something within the atom.

It can be shown further that if all the electrons in an atom are in the same plane, the effect on the intensity of the reflected X-ray beam of turning the atom will be greater than one per cent. unless the effective radius of the atom is less than 10^{-10} cm. Other considerations, however, prove that the radius of the atom must be much greater than this.

There is a relatively small number (26) of electrons in the iron atom, and it appears probable that 8 of these, as valence electrons, are at a considerably greater distance than the others from the center of the atom. It is therefore difficult, though perhaps not impossible, to imagine an arrangement of the electrons so isotropic that a rotation of the atom will not produce an appreciable change in the intensity of the reflected X-ray beam.

The most obvious explanation of our negative result is that it is not the atom which is the elementary magnet, but that it is either the positive nucleus, as suggested by Merritt, or the electron, as suggested by Parson.

If the ultimate magnetic particle is not rotated to any great extent by the magnetic field, no conclusions can be drawn from our experiments. It appears much more probable however, that the molecular magnet is capable of being turned through a large angle, and on this basis we may conclude that:

1. The ultimate magnetic particle is either *the atom or something within the atom.*
2. If the atom is the ultimate magnet, its electrons are not all distributed in the same plane, as assumed by Bohr, but are arranged very nearly isotropically.
3. Our experiments are in accordance with the hypotheses that the atomic nuclei or the electrons themselves are the ultimate magnetic particles.

In a subsequent paper we shall describe our experiment in greater detail, and shall discuss more fully the significance of our negative result.

Arthur H Compton,
Oswald Rognley
University of Minnesota

APPARATUS FOR PHYSIOLOGICAL AND PHYSICAL LABORATORIES

An Adjustable Stand for Graphic Experiments.—The stand illustrated in the figure was designed by me, twenty-three years ago, for use with the piston-recorder for air transmission. It has served its purpose so admirably, and is so well adapted for all graphic work where a very delicate adjustment of the writing point is required, that it has seemed to merit a description in print.

The features that have commended it especially are its simplicity, its great delicacy of movement and absence of backlash, and the ability to use it at all times for any of the purposes for which a small stand is necessary.

Its construction is not difficult, but requires accurate workmanship.

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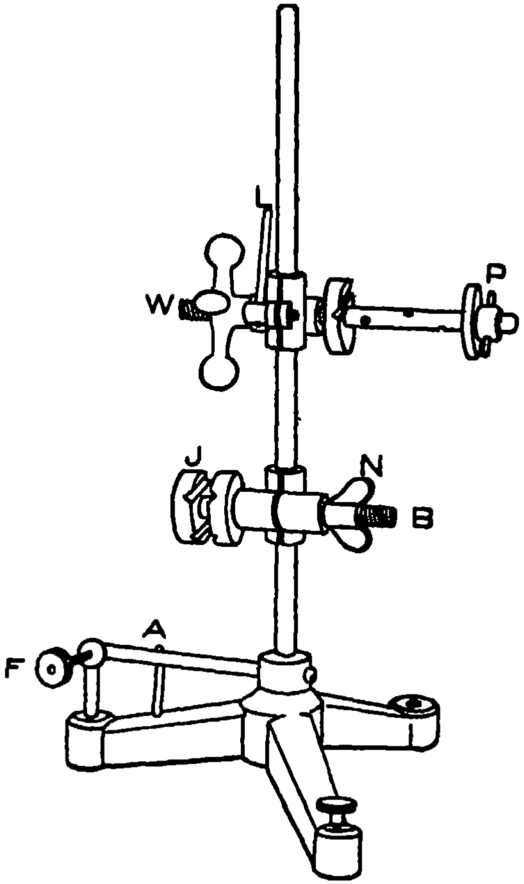
[2] K. T. Compton and E. A. Trousdale, *Phys. Rev.*, 5, 315 (1915).



The central part of the tripod base is bored and faced on the lathe, and the hole is reamed to a standard size. The base is then placed on an arbor and the lower surface of the hub is turned to correspond with the front. The lower end of the vertical rod is ground into the hole. A collar is securely fastened to this part of the rod, and its lower surface turned to an accurate bearing. A long rod is screwed into the collar, and is firmly pressed against the adjusting screw *F* by the steel rod *A*, which acts as a very strong spring. The vertical rod is fastened to the base by a screw in its lower end, and a spring washer which bears against the turned surface. As the horizontal rod has a considerable length, and the adjusting screw a fine thread, the rotation of the rod when the screw is turned is very slow, and is under perfect control. The elasticity of the spring rod is sufficient to allow the necessary movement in graphic experiments, and is rigid enough to prevent rotation when the stand is used for ordinary purposes.

The vertical rod of the stand just described has a diameter of 10 mm. A much larger stand of slightly modified construction, with a heavy base, and a rod 25 mm. in diameter, is a most useful addition to the equipment of the laboratory, and forms a very satisfactory support for a reading telescope. The lower end of the rod is turned to a shoulder, and is fitted to the base with a screw and a washer, as in the previously described instrument. The collar into which the horizontal arm is inserted is not permanently fastened to the central rod, but is clamped by a thumb-screw which permits the rod to be rotated to any extent before using the fine adjustment. A leveling-screw, and a clamp-screw in the hub not shown in the figure are also desirable additions.

Universal Clamps.—The clamps shown in the drawing were designed to be used on the adjustable stand. Within the limits of their capacity they enable flat objects, and rods of round, square, triangular and oblong section, to be held very firmly in any position without marring. They can be easily adapted to any stand and modified in various ways. The clamps are attached to the supporting rod by a split cast-iron piece in the shape of two crossed cylinders, which are carefully bored at right angles to each other. The bolt which passes through the horizontal cylinder has the same size as the vertical rod, and in one form has for the head the iron disc *J*, which is permanently fastened to it. A similar disc revolving on the bolt, forms the second jaw. The two discs are turned, and their inner surfaces have parallel V grooves which accurately correspond, and a recess in each for a spiral spring which opens the jaws when the nut is loosened. The object to be held is fixed in the jaws, and the clamp to the stand by the single nut *N*.

The upper clamp is fixed to the vertical rod independently by the lever *L* which turns a screw in the split projection. The bolt *W* has a number of transverse holes which enable the right hand disc to be fastened in different positions by the pin *P*. This arrangement allows objects of considerable width to be held by their edges. A supporting screw in the movable disc opposite the groove is sometimes used to prevent tipping and wedging of the disc under strong pressure, but it is generally not required.

Universal Tripod Bases.—Of all laboratory implements the tripod stand is probably the one that is most constantly and universally employed. A tripod base forms the foundation of a great number of scientific instruments; it is therefore desirable to have a number of accurately made bases for use with interchangeable apparatus, and adaptable to a great variety of purposes.

The ordinary way of fastening the standard to a tripod base is by means of a screw on the end of the rod. This is permissible when the rod is to be left in position permanently, but when it has to be removed frequently, it is very inconvenient, as a special wrench is required for the operation. When accurate construction is required it is necessary to reduce the diameter of the lower end of the standard to form a shoulder, and to cut the screw in a lathe. This adds considerably to the expense and difficulty of fitting apparatus to the base. A much simpler and better mode of attachment can be employed which has proved itself to be very satisfactory in my laboratory. The bases that I have made are of two sizes. The larger one covers a circle of 30 cm. and weighs 5 kilograms. Its center is a cylinder 8 cm. in diameter and 7 cm. in height. This base is like that of the large adjustable stand which I have described, and is turned and bored on the lathe in exactly the same manner as that. The central hole has a diameter of 19 mm. and the standards are clamped in it by a large brass screw which passes horizontally through the center of the hub. As the screw has a large head with four spokes like the hand-nut on the universal clamp figured in the drawing, the rods and bushings are held with the greatest firmness, but they can be changed almost instantly. This kind of attachment allows a certain amount of vertical movement of the standard of a table, or of apparatus, when variation of height is desirable. When a more extensive elevation is necessary the tripod can be placed over a hole in the table through which the rod can pass, or it can be supported on rods clamped by brass set-screws in 13 mm. holes in the cylindrical feet. These supplementary rods may be used as substitutes for leveling-screws. If such screws are required they are made with brass cylindrical nuts which are clamped in the holes in the feet. These holes are exactly at right angles to the plane of the bottom of the feet, it is therefore possible to have four vertical rods, parallel to one another, attached to the same base. This is a great convenience in assembling complicated combinations of apparatus. Rods smaller than the holes can be clamped by means of bushings. When these bushings are of non-conductors the rods can be insulated, or the rods may be made of these materials.

The smaller base has all the features of the one just described, and weighs about three fourths of a kilogram. The holes in the feet are 10 mm. in diameter, and the central one 13 mm. These bases can be bored while clamped together in pairs. This insures exact correspondence of the holes when the bases are used together in combinations. They form excellent end supports for the horizontal rod of an optical bench, or similar apparatus. They may be used instead of flanges for table tops and wheels. They can be fastened easily to the wall or ceiling by screws passing through the holes in the feet, or be employed in the construction of a wall bracket of adjustable height. In order to make such a bracket two short rods in two of the supplementary holes are held in corresponding holes in a block of wood screwed to the wall. A long rod in the anterior leg terminates in a rectangular piece through which passes a horizontal rod abutting against the wall. A table top is attached to the central standard when an adjustment for height is desired, or it may be screwed or clamped to the anterior rod.

FREDERICK W. ELLIS

MONSON, MASS.

SCIENCE

FRIDAY, NOVEMBER 2, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

THE STRUCTURE OF ATOMS, AND THE EVOLUTION OF THE ELEMENTS AS RELATED TO THE COMPOSITION OF THE NUCLEI OF ATOMS[1]

THE general theory of the structure of the atom which seems to be most closely in harmony with the facts is that developed by Rutherford. His theory assumes that the atom consists of a central nucleus or sun, and that the satellites of the miniature solar system are the negative electrons. The central nucleus is supposed to contain almost all of the mass of the atom, and is charged with positive electricity. That this nucleus is very minute in comparison with the size of the atom is indicated by the work of Rutherford, of Geiger and Marsden, and of Darwin, who find that the deflection of alpha particles, which are shot from radioactive atoms at speeds which approach 20,000 miles per second and so pass directly through other atoms, is of such a character as to indicate that the positive charge of the atom is very highly concentrated. Thus Darwin's work indicates that the maximum diameter of the nucleus of a hydrogen atom (1.7×10^{-13} cm.) is only about one-one hundred thousandth of the diameter usually assumed for the atom. On this basis the atom would have a volume a million-billion times larger than that of its nucleus, and thus the nucleus of the atom is much smaller in comparison with the size of the atom than is the sun when compared with the dimensions of its planetary system.

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[1] Address presented at the Symposium on the Structure of Matter at the New York meeting of the American Association for the Advancement of Science. A bibliography will be found in the following papers: *Jour. American Chemical Society*, 37, 1367–1421 (1915), 39, 856–879 (1917); *Philosophical Magazine*, 30, 723–734 (1915).

The special modification of Rutherford's theory which has met with the most success is that due to Bohr. The very remarkable features of this theory have been made the subject of Professor Millikan's address, which has already been given, so they need not be mentioned here. However, in spite of its success, Bohr's theory possesses in common with the other special views of atomic structure which have been developed, the limitation that its application has been restricted to one special class of phenomena, those of radiation, and that it is too simple to give a mechanism which will act as any except the most simple of atoms. In the Bohr atom the negative electrons external to the nucleus are all supposed to lie in the same plane with the nucleus, while the structural relations of organic molecules seem to indicate that at least the outer electrons do not lie in a plane (except when only two in number) but that they have a three-dimensional arrangement.

It was found by Moseley that if the elements are arranged in order according to their X-ray spectra, they fall in the same order as they do in the periodic system. If arranged in this way, beginning with hydrogen as 1, and helium as 2, they are said to be arranged according to their atomic numbers. In our ordinary system of elements there are in all 91 elements from helium to uranium inclusive, and in addition to these there is hydrogen which makes 92 in all. Of these 86 or 87 have been discovered and 6 or 5 remain to be found. It is the purpose of this paper to present some relations which have been found by the writer and his students, which have a bearing on the structure of the atoms of these elements, upon the problem of their stability, and their formation by evolution.

1. ARE THE ELEMENTS INTRA-ATOMIC COMPOUNDS OF HYDROGEN?

One of the first suggestions in regard to the structure of the atom was made by Prout in 1815, or a little over a century ago. Prout found, on the basis of his own experiments and the more accurate work of Gay-Lussac, that if the atomic weight of hydrogen was put as 1.00, the atomic weights of the other elements became whole numbers as follows:

PROUT'S ATOMIC WEIGHTS (1815 A.D.) (WITH THE 1915 ATOMIC WEIGHTS ON HYDROGEN BASIS IN PARENTHESES)

Hydrogen	1.0	(1.000)
Carbon	6	(11.91)
Nitrogen	14	(13.90)
Phosphorus . .	14	(30.78)
Oxygen	16	(15.88)
Sulphur	16	(31.82)
Calcium . .	20	(39.76)
Sodium	24	(22.82)
Iron	28	(55.41)
Zinc	32	(64.86)
Chlorine	36	(35.46)
Potassium	40	(38.80)
Barium	70	(136.31)
Iodine	124	(125.94)

If Prout's atomic weights had proved exactly correct, his claim that hydrogen is the protyle (πρώτη ὕλη) or fundamental element, might have seemed justified, but when it was found that these weights were very far from correct his hypothesis was largely discarded.

The prejudice which existed a few years ago against Prout's idea is well shown by a quotation from von Meyer's "History of Chemistry," printed in 1906.

> During the period in which Davy and Gay-Lussac were carrying on their brilliant work, and before the star of Berzelius had attained to its full luster, a literary chemical event occurred which made a profound impression upon nearly all the chemists of that day, viz., the advancement of Prout's hypothesis. This was one of the factors which materially depreciated the atomic doctrine in the eyes of many eminent investigators. On ac-

count of its influence upon the further development of the atomic theory this hypothesis must be discussed here, although it but seldom happens that an idea from which important theoretical conceptions sprang, originated in so faulty a manner as it did.

However, a careful study of the most accurately determined of the recent atomic weights reveals some very remarkable relationships. If first of all we make the assumption, as a subject for argument, that the heavier atoms are built up from hydrogen atoms, then it is found that the atoms are in nearly all cases lighter than they should be on the basis of such an hypothesis. Thus, if the following atoms of low atomic weight are considered, it is found that nearly all of them weigh 0.77 per cent. too little.

TABLE I

Atom of	Atomic Weight	Difference from a Whole Number	Per Cent. Variation
Helium . . .	3.97	−0.03	−0.77
Boron . . .	10.92	−0.08	−0.77
Carbon . . .	11.91	−0.09	−0.77
Nitrogen . .	13.90	−0.10	−0.70
Oxygen . . .	15.88	−0.12	−0.77
Fluorine .	18.85	−0.15	−0.77
Sodium . .	22.82	−0.18	−0.77

Therefore, if these atoms are built from hydrogen atoms, there must be during their formation a loss in weight, and presumably in mass, equal to 0.77 per cent. This will be called the "packing effect." When all of the 26 elements from helium of atomic number 2, to cobalt (No. 27) are considered, it is found that with the exception of the four elements, beryllium, magnesium, silicon, and chlorine, which have atomic weights higher than the corresponding nearest whole numbers, the average packing effect of the elements is again −0.77 per cent. This constancy of the packing effect suggests that the variation is due to some single cause, though the four exceptional cases cited above, show that there is undoubtedly some other complicating factor. The discovery by Thomson and Aston that the similar exceptional case of neon is due to the admixture of an isotope of higher atomic weight suggests that it may not be impossible to find a cause for the exceptional behavior in the four other cases.

It has formerly seemed difficult to explain why the atomic weights referred to oxygen (16.00) as a basis are so much closer to whole numbers than those referred to hydrogen as 1.00, but the explanation is indeed very simple from the point of view presented here. The closeness of the atomic weights on the oxygen basis to whole numbers, is indeed extremely remarkable. Thus for the eight elements from helium to sodium the average deviation is only 0.02 unit, or less than the average probable error of the atomic weight determinations, and for all of the first 27 elements the average deviation from a whole number is, though more, increased only to 0.09 unit, when the *sign* of the deviation is considered. If it is *not* considered the deviation is reduced to 0.01 unit for 21 elements. The probability that such values as these could be obtained by accident is altogether unworthy of consideration. If an oxygen atom is a structure built up of 16 hydrogen atoms, then according to the ordinary theory that mass and weight are strictly additive, the weight of an atom of oxygen should be exactly 16 times the weight of a hydrogen atom. Now, according to the present system of atomic weights the weight of an atom of hydrogen is taken as 1.0078, so the oxygen atom should weigh 16.125. However, it is found to weigh 16.00. The difference between 16.125 and 16.000 is the value of the packing effect, and *if this effect were exactly the same for all of the elements except hydrogen, then the choice of a whole number as the atomic weight of any one of them, would, of necessity, cause all of the other atomic weights* *to be whole numbers.* Though this is not quite true, it is seen that the packing effect for oxygen is 0.77 per cent., which is the average packing effect for the twenty-one elements considered (elements of low atomic number). Therefore these elements, which have packing effects equal to that of oxygen, will have whole numbers for their atomic weights. Since, too, the packing effect is very nearly constant, all of these 21 elements will have atomic weights close to whole numbers.

While according to our ordinary experience mass and weight seem to be additive, the question may be raised whether in the formation of atoms, which is a process which is, up to the present time, outside our experience, this is true. There are three remarkable facts to be explained: first, the atomic weights of the lighter elements on the *hydrogen* basis approximate whole numbers; second, the deviations from whole numbers are *negative,* and third, these deviations are practically constant in magnitude.

It has been already stated that according to the work and calculations of Darwin, and of Geiger and Marsden, the nucleus of the atom is extremely minute in comparison with the size of the atom, so that in the nucleus the mass, if the determined dimensions of atoms and their nuclei are at all correct, is many thousand billion times more concentrated than in the atom. If the nucleus is complex, the electromagnetic fields of the charged particles would be extremely closely intermingled in the nucleus, and it would seem reasonable to assume that this would affect the mass, so that the mass of the whole nucleus would not be equal to the sum of the masses of its parts.

Let us take an extremely simple case for calculation, and find how closely packed the charged particles in a nucleus would have to be to cause the observed decrease in weight (0.77 per cent.) which is found for most of the atoms. In making such a calculation, as a guide for our assumptions, we have the observed fact that radioactive atoms shoot out both positively charged alpha particles and negative electrons at such high speeds that it seems probable that they come from the *nucleus of the atom.* The observed relations between the products of the radioactive changes support this idea very strongly indeed. Thus there seem to emerge from the nuclei of complex atoms both positively and negatively charged particles, and the negatively charged particles are found to be negative electrons. This point should be emphasized, since many workers on atomic theory have endeavored to construct their imaginary nucleus of positively charged particles alone.

The simplest case for calculation[2] would then be for a nucleus consisting of one positive and one negative particle. Let the distance between the particles be d, the charges respectively e_1 and e_2, let the velocity of the particles be along the straight line connecting them and equal to u. Then if c is the velocity of light, the particles have a longitudinal momentum which differs from the momentum calculated by ordinary mechanics for electrically neutral particles possessing mass by an amount equal to

$$2\frac{u}{c^2}\cdot\frac{e_1e_2}{d}.$$

This may be called the mutual electromagnetic momentum of such a system of particles. The mutual electromagnetic mass corresponding to this is

$$\Delta m_1 = \frac{2}{c^2}\cdot\frac{e_1e_2}{d} = \frac{2}{c^2}\frac{e^2}{d} \quad \text{since } e_1 = e_2.$$

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[2] For this calculation see the following papers by Harkins and Wilson: *Proc. Nat. Acad. Sciences,* 1, 277–78 (1915); *J. Am. Chem. Soc.,* 37, 1372–78 (1915), and *Phil. Mag.,* 30, 725–28 (1915).

The corresponding mass of one particle is

$$m_1 = \frac{2}{3}\frac{e^2}{c^2 R},$$

where R is the radius of the electron; so

$$\frac{\Delta m}{m_1} = \frac{3R}{d}.$$

In the application of this last equation, R is to be taken as the radius of the positive electron, since it is assumed that it is the seat of practically all of the mass of the atom. In order to produce a decrease of mass equal to 0.77 per cent., which is the average decrease in weight as calculated from the atomic weights, the two electrons should approach until their distance is 400 times the radius of the positive electron. Thus a packing effect of 0.77 per cent. would be produced by a moderately close packing of the electrons in the nucleus.

The packing effect for oxygen, which has been taken as the basis for our modern atomic weights, is exactly equal to the average value given above. If the number representing the atomic weight of hydrogen on the oxygen basis, 1.0078 is decreased by this percentage amount, it becomes equal to 1.000, so the oxygen system of atomic weights may be considered as a hydrogen system, with hydrogen taken as 1.000, but where the weight of the hydrogen atom is taken *after* it has been subjected to the average packing effect of 0.77 per cent. Thus in going over from the hydrogen to the oxygen system of atomic weights, the chemists who made the change were, without knowing it, making allowance for the average packing effect, for, while the atomic weight of hydrogen is 1.0078, the atoms heavier than hydrogen have atomic weights which are near what they should be if they were built up of units of weight very close to 1.000. On the other hand, this unit of mass must be somewhat variable to give the atomic weights as they are, even although a part of the variation, in some cases, may be due to the inaccuracy with which the atomic weights are known. This leads either to the supposition (1) that the atoms are built up of some unknown elementary substance, of an atomic weight which is slightly variable, but is on the average extremely close to 1.000, and which does not in any case deviate very far from this value, or to the idea (2) which is presented in this paper, that the *nucleus* of a known element is the unit of structure. The atom of this known element has a mass which is close to that of the required unit, and it has been proved that the decrease of mass involved in the formation of a complex atom from hydrogen units is in accord with the electromagnetic theory. The adoption of the first hypothesis would involve much more complicated relations. It would necessitate the existence of another elementary substance with an atomic weight close to that of hydrogen, it would involve a cause for the increase of weight in the formation of some atoms, and a decrease in other cases, and it would also involve the existence of another unit to give the hydrogen atom.

It may be well to consider here the *probability* that the elements from helium to cobalt, atomic numbers 2 to 27, may have atomic weights as close to whole numbers as they are on the oxygen basis, entirely by accident. For example we may calculate the chance that each of the atomic weights should be as close as it is to a whole number, and we find that there is one chance in five thousand billion billion. Another probability is that the sum of the deviations from whole numbers shall not exceed the sum found experimentally. This gives the result that there is one chance in fifteen million. Thus, in the words of Laplace as applied to a calculation of probability in connection with an astronomical problem, that the atoms are built up of units very close to one, "est indiquée avec un probabilité bien supérieure à celle du plus grand nombre des faits historiques sur lesquels on ne se permet aucune doute.''

THE ATOMS ARE INTRA-ATOMIC HELIUM-HYDROGEN COMPOUNDS

The atoms of radioactive substances are known to shoot off alpha particles with speeds as high as 20,000 miles per second. These alpha particles carry two positive charges, have an atomic weight of 4.0, and when they are collected and take up negative electrons, give ordinary helium. They may be thought of as the nuclei of helium atoms, and seem to be shot out from the *nucleus* of the more complex atom such as that of radium or thorium. Fig. 1 illustrates the change which occurs in this process. Any special element, such as radium (which is an extremely active solid, with a valence of 2, and belonging therefore to group 2) has its valence reduced by two when the atom ejects an alpha particle (which carries two positive charges), and in this case changes into the inactive gas, radium emanation or niton. The alpha particle has a weight of 4, and niton has an atomic weight which is 222, or four less than that of radium (226). That this is a general rule was discovered by Soddy, and it was verified later by Fajans, Russell, von Hevesy and Fleck.

Let us picture the changes which occur during the long chain of processes which

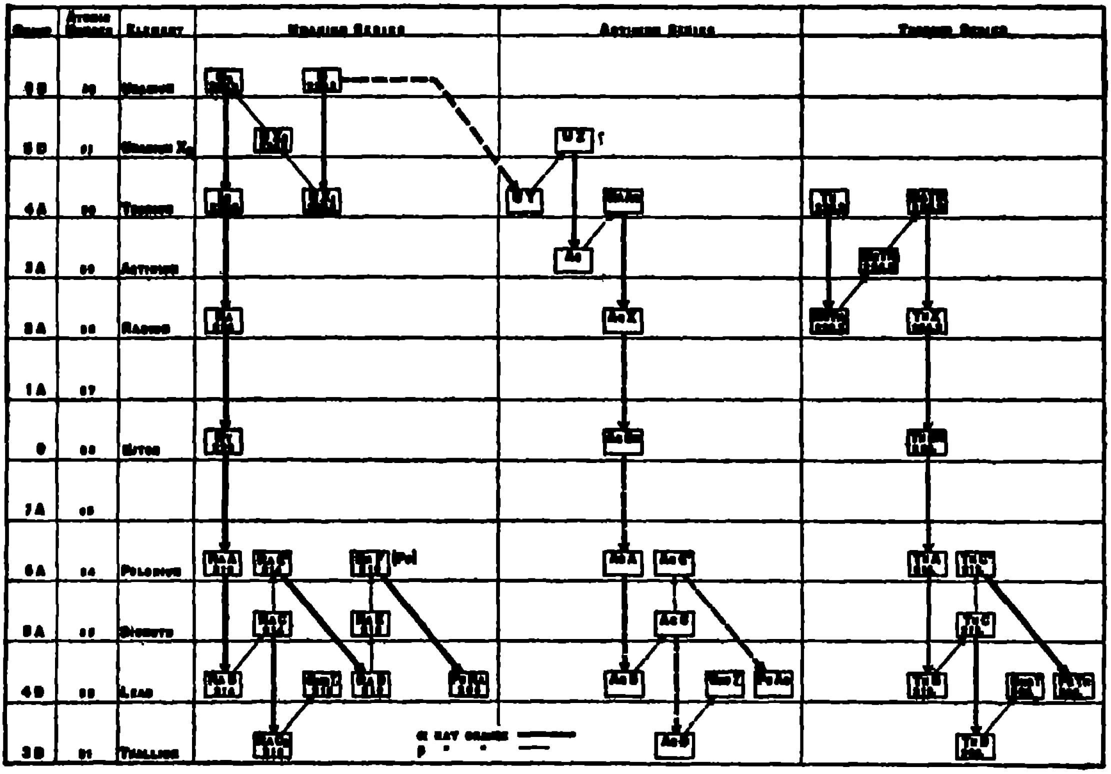

Fig 1. Transformations of the Radioactive Elements. The α and β changes of the radio-active elements. Note that the atoms of even atomic number are more numerous than those of odd atomic number. Thus there are 32 of the former class to 11 of the latter.

converts Uranium 2 into Radium B, which is a variety (isotope) of the element lead. We will assume that the nucleus of a uranium 2 atom, so far as its composition, but not its constitution, is concerned, is made up of the nucleus of a Radium B atom (which nucleus we will designate by $(\mathrm{RaB})_n$, where the subscript *n* denotes that it is the nucleus only), and 5 α^{++} particles, where the two plus signs serve to remind us that the alpha particle carries a double positive charge. Then the changes which occur, beginning with Uranium 2, and ending with Radium B, are such that in each successive change one of these α^{++} particles is emitted by the nucleus.

TABLE[3]

The Changes in the Composition of the Nuclei of Atoms when they eject Alpha Particles (Nuclei of Helium Atoms) of Weight 4, and carrying Two Positive Charges, with Corresponding Changes in the Non-nuclear Electrons

Group	Atomic Number	Name of Element	Atomic Weight	Composition of Nucleus	+ Charge on Nucleus	Number of Inner Non-Nuclear —Electrons	Number of Valence Electrons
6	92	Uranium 2	234	$82 + (\mathrm{RaB})_n + 5\alpha^{++}$	(Note 3) $82 + 10 = 92$	86	6
4	90	Ionium	230	$82 + (\mathrm{RaB})_n + 4\alpha^{++}$	$82 + 8 = 90$	86	4
2	88	Radium	226	$82 + (\mathrm{RaB})_n + 3\alpha^{++}$	$82 + 6 = 88$	86	2
0	86	Niton	222	$82 + (\mathrm{RaB})_n + 2\alpha^{++}$	$82 + 4 = 86$	86 (Decrease here by 8)	0
6	84	Radium A (Isotope of Polonium)	218	$82 + (\mathrm{RaB})_n + 1\alpha^{++}$	$82 + 2 = 84$	78	6
4	82	Radium B	214	$82 + (\mathrm{RaB})_n$	$82 + 0 = 82$	78	4

According to this table it would seem that when the nucleus of an atom loses an α^{++} particle, and thus decreases its positive charge by two, the outer atom must lose two negative electrons in order to keep the atom electrically neutral. That this is actually the case seems to be indicated by the fact that there is evidence in the chemical properties that the number of valence electrons decreases by two. According to this idea, when the nucleus shoots out an α^{++} particle, the atom, as a whole, loses an entire helium atom by the time it becomes electrically neutral. That the loss of the negative electrons in alpha disintegrations has not been detected is probably due to the low velocities with which such external electrons leave the outer part of the atom.

THE ELEMENTS OF EVEN ATOMIC NUMBER, OR HELIUM SERIES ELEMENTS

While the alpha disintegrations of atoms are known only among the heaviest atoms, and extend downward from element ninety-two (uranium) to element eighty-two (lead), it occurred to me several years ago that this system undoubtedly should extend downward still further, and quite possibly even to the lightest elements. The indication that the system still holds should be found in the atomic weights, for these should increase in steps of four between the atoms of even number. Thus the atomic weights of the lighter elements, if *exactly* this same system holds, should be as follows:

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[3] The most doubtful feature of this table is the assumption that the nuclear charge is equal to the atomic number, but the insertion of $92 + \mu$ for 92, of $90 + \mu$ for 90, etc., where μ is a whole number, and probably either zero or else very small, removes this doubtful feature.

Atomic Number	Atomic Weight
2	4
4	8
6	12
8	16
10	20
12	24
14	28
16	32

Now, the extremely remarkable fact is that *the atomic weights given above are the atomic weights of the even numbered elements,* with only one exception.

If the twenty-six elements from helium to cobalt (atomic weights from 4 for helium to 59 for cobalt), inclusive, are considered, it might be assumed that the even numbered, or one half of the elements, should have atomic weights divisible by 4. Indeed, while there are two exceptions to the exact system, just 13 of these elements do have such atomic weights, and every possible multiple of 4 but one is taken, as is shown in the following table:

1 × 4 = helium
2 × 4 = missing, and replaced by 2 × 4 + 1
3 × 4 = carbon
4 × 4 = oxygen
5 × 4 = neon
6 × 4 = magnesium
8 × 4 = sulphur
9 × 4 = missing, but replaced by 10 × 4 = argon
10 × 4 = calcium
11 × 4 = scandium
12 × 4 = titanium
13 × 4 = chromium
14 × 4 = iron

Thus, since the *even-numbered* elements of *high atomic weight* give off *helium atoms* when they disintegrate, and in such a way that for each helium atom lost the *heavy atom* changes into the atom of the element which has an *atomic number which is smaller by 2;* and since the *even numbered elements* of *low atomic weight* have *atomic weights which increase by four, or the atomic weight of helium, for each increase of 2 in the atomic number, the natural assumption is that the even numbered elements are compounds of helium.* To distinguish them from chemical compounds they may be called intra-atomic. At least for the elements of low atomic number, their general formula is *nHe′*, where the prime is added to indicate an intra-atomic compound.

THE ELEMENTS OF ODD ATOMIC NUMBER, OR ELEMENTS OF THE HELIUM-H_3 SERIES

If the odd-numbered elements, beginning with atomic number 3, or lithium (atomic weight = 7), are built up according to a

TABLE III

The Helium—H_3 System of Atomic Structure H = 1.0078

	0	1	2	3	4	5	6	7	8	
At. No.	2	3	4	5	6	7	8	9		
	He	Li	Be	B	C	N	O	F		
Ser. 2. .	He	He + H_3	2He + H	2He + H_3	3He	3He + H_3	4He	4He + H_3		
Theor .	4 00	7 00	9.0	11.0	12 00	14.00	16.00	19 00		
Det. .	4 00	6.94	9 1	11.0	12 00	14.01	16.00	19 00		
At. No	10	11	12	13	14	15	16	17		
	Ne	Na	Mg	Al	Si	P	S	Cl		
Ser 3. .	5He	5He + H_3	6He	6He + H_3	7He	7He + H_3	8He	8He + H_3		
Theor. .	20 0	23 0	24 00	27 0	28 0	31 00	32 00	35.00		
Det .	20 0	23 0	24 32	27.1	28.3	31 02	32 07	35.46		
At. No.	18	19	20	21	22	23	24	25	26	27
	A	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co
Ser. 4 .	10He	9He + H_3	10He	11He	12He	12He + H_3	13He	13He + H_3	14He	14He + H_3
Theor.	40 0	39.00	40 00	44.0	48 0	51.0	52.0	55 00	56.00	59 00
Det. .	39 9	39 10	40 07	44 1	48 1	51.0	52 0	54.93	55.84	58.97

Increment from Series 2 to Series 3 = 4He. Increment from Series 3 to Series 4 = 5 He (4 He for K and Ca). Increment from Series 4 to Series 5 = 6He.

similar system, their atomic weights should be as follows:

Atomic Number	Atomic Weight
3	7
5	11
7	15
9	19
11	23
13	27
15	31
17	35
19	39

There is here again the remarkable fact that with one exception these are the atomic weights of the odd-numbered elements. The general formula for the odd-numbered elements may be expressed as $nHe' + H_3'$. From the numerical standpoint it will be seen that the system here proposed corresponds to the formulas found for the atomic weights by Rydberg in 1897. He found that most of the atomic weights can be expressed by $2m$ or $2m - 1$, where m is a whole number.

The proposed structure for the 26 elements of low atomic number is presented in Table III. While it is not meant that in every minute detail this table is necessarily correct, very strong evidence has been found for its validity as a general relationship.

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(*To be continued*)

SCIENTIFIC EVENTS

CHEMICALS AND WAR IN ENGLAND

Professor W. J. Pope, addressing a meeting of teachers at the Regent-street Polytechnic on October 6, according to a report in the London *Times*, said that Germany prepared for war by the establishment of a huge chemical industry, which was built up about the coal-tar industry, and then by exporting a very large proportion of the world's requirements of coal-tar colors, and pharmaceutical and photographic products.

That success was achieved in spite of the fact that England once possessed the whole of the heavy chemical industry of the world. We formerly produced practically all the nitric and sulphuric acids, and the greater part of the alkali used throughout the world. That had been taken from us as the result of Germany's foresight and exploitation of scientific ability. The coal-tar industry was established originally in this country. Until ten years ago Germany was practically dependent on us for crude coal-tar, and for the simpler first products separated from coal-tar.

Alluding to the establishment of the department for scientific and industrial research with an endowment of £1,000,000, Professor Pope said: The question we want answered is why that experiment was not made twenty years ago, at a time when it would have been undoubtedly successful in preventing the horrors of the last three years? We have suffered in the past from the exclusively British method of making the specialist entirely subservient to the administrator, the administrator being generally chosen because he is available, because he is politically acceptable, and because he knows nothing whatever about the subject which is to be administered and is therefore not likely to be prejudiced by any previous convictions. That process of appointing someone who knows nothing, to supervise the work of some one who does know how to do the job, seems to have been at the bottom of a great many of our misfortunes in the past.

Even in 1915 the government applied this same method to reestablish the coal-tar industry in this country. An organization was established in which all the people in control were men who knew nothing whatever about chemistry or science, and naturally enough the government organization has proved not only a great failure, but has had the further effect of inhibiting the reestablishment of the coal-tar industry. That is to say, the organization apparently was to do everything that was necessary, and consequently private effort was to a considerable extent hampered, and could not get on with the important problem of reestablishing this fine chemical industry.

Such prevalent, but entirely mistaken, activity arises, I think, from a lack of education. If it were generally demanded that no person should be regarded as decently educated who had not mastered the rudimentary principles of natural science and of scientific method, this farce, staged for the amusement of the whole world, in connection with this coal-tar color question, would have been impossible.

The law had absorbed a great proportion of the youth of the nation who were most fitted for a scientific career. The young man who was capable of advancing knowledge, either in science or in any other branch of learning, must be taught to regard it as his duty, not to use his abilities simply for the sake of acquiring an easy and comfortable position in life. Above all, we must prevent the young man of the type I have named from going into such a blind alley occupation as that of the law, with the ultimate prospect of quitting the world, having left nothing behind, and having made no contribution whatever to its progress.

Professor Armstrong, who presided, declared that the present position of chemistry in this country was deplorable, owing to government ignorance and indifference. The Board of Trade had, advisedly and of set purpose, it would seem, put all scientific advice aside, and had taken measures which had not only proved a failure but which had actually retarded the development of the dyestuff industry. The government seems to be bent on putting us back, body and soul, into the hands of the Germans, in so far as the higher interests of chemistry are concerned.

FACULTY CHANGES AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

At the Massachusetts Institute of Technology the faculty changes have introduced some new problems since there has been so much demand by the U. S. government and by industrial corporations related to the war for men of technical skill. So great has been this draft that in the department of electrical engineering one third of the staff has been called away, in mechanical engineering a dozen men have gone into war work while civil engineering, chemistry, naval architecture and the other departments have sustained serious losses. On the other hand, the demands for instruction have not only not decreased, for the registration is but slightly less than normal with much the same distribution through courses, but are to a considerable extent greater, for the institute is furnishing instruction in academic and engineering lines to the schools of aeronautics for the army and the navy, and is carrying on no less than three schools for deck officers and the school for marine engineers.

Changes already announced include the retirement of Professor Charles R. Cross, with the title of professor emeritus, and the appointment of Professor E. B. Wilson, of the department of mathematics, to the chair of mathematical physics and head of the department of physics. Professor C. L. Norton has been appointed professor of industrial physics, and Dr. Charles R. Mann has been appointed professor of education and educational research.

The following is the list of promotions:

Instructor A. L. Goodrich to assistant professor of mechanical drawing and descriptive geometry; Instructors F. L. Hitchcock and Joseph Lipka to assistant professor of mathematics; Instructor H. P. Hollnagel to assistant professor of physics; Instructor R. E. Rogers to assistant professor of English; Assistant A. B. English to instructor in machine tool work; Assistant W. T. Haines to instructor in electrical engineering.

The special lecturers and teachers thus far named are, William S. Franklin in physics and electrical engineering, Eliot Putnam in architectural history, Charles R. Gow on foundations, Edward F. Rockwood on concrete design, and T. W. Sprague on electricity in mining.

The appointments of new men to places in the institute instructing staff include: In civil engineering, James B. Newman to be assistant. In mechanical engineering, Robert DeCourcey Ward, DeWitt M. Taylor, to be instructors; Chester A. Rogers, Andrew J. Ferretti, John A. Lunn, Paul Hatch, and H. C. Parker to be assistants. In mining and metallurgy, Frank H. Ellsworth and William A. Wissler, to be assistants. In architecture, Paul W. Norton to be assistant. In chemistry and chemical engineering, John B. Dickson, Henry W. Stuckeln, Charles R. Park, Charles M. Wareham; Ralph D. McIntire and Earl P. Stevenson to be instructors, and Roger B. Brown, James F. Maquire, Jr., Alden D. Nute, Chandler T. White, Walter G. Whitman, Edward Zeitfuchs, Louise P. Johnson, Frank F. Hansen, Earle E. Richardson and A. G. Richards to be assistants. Amy Walker to be research assistant in chemistry and Duncan A. MacInnes research associate and Leon Adler, research assistant in physical chemistry. In electrical engineering, Edwin A. Ekdahl, and Clifford E. Lansil, to be assistants In biology and public health, Dr. Francis H. Slack, to be instructor, and Elmer H. Heath, Jr., to be assistant. In physics, Arthur C. Hardy and Joseph DeL. McManus to be assistants. In naval architecture, P. L. Rhodes to be assistant, and Edwin E. Aldrin, George M. Denkinger and Edward P. Warner, to be assistants in aeronautical engineering. In electrochemistry, Casimiro Lana to be assistant. In mechanical drawing, Charles R. Mabie and Walter C. F. Gartner to be assistants. In mathematics, W. H. Wilson to be instructor. In business management, Erwin H. Schell to be assistant professor. In English and modern languages, Frank L. Hewitt, Penfield Roberts and Arthur L. McCobb to be instructors.

THE UNIVERSITY OF PITTSBURGH AND THE ARMY MEDICAL SERVICE

FORTY-TWO per cent. of the teaching staff of the school of medicine, University of Pittsburgh, have enlisted in the medical service of the government. The following men are in Base Hospital No. 27:

Surgery.—Major Robert T. Miller, professor of surgery; Captain Paul R. Sieber, assistant professor of surgery; Captain Stanley S. Smith, assistant professor of ophthalmology; Captain John R. Simpson, assistant professor of otology; Captain Edward J. McCague, instructor in surgery; First Lieutenant J. W. Robinson, instructor in surgery; Captain Eben W. Fiske, demonstrator in orthopedic surgery; First Lieutenant R. J. Frodey, instructor in gynecology; First Lieutenant John H. Wagner, demonstrator in surgery; First Lieutenant Bender Z. Cashman, instructor in surgery.

Medicine.—Major James D. Heard, professor of medicine; Major T. S. Arbuthnot, associate professor of medicine; Major Howard G. Schleiter, assistant professor of medicine; First Lieutenant R. R. Snowden, instructor in medicine; First Lieutenant A. H. Colwell, instructor in medicine; First Lieutenant C. B. Maits, demonstrator in medicine; First Lieutenant A. P. D'Zmura, demonstrator in medicine.

Laboratory.—Captain H. H. Permar, instructor in pathology; First Lieutenant F. M. Jacob, instructor in immunology.

Registrar.—Captain Edward W. sur Horst, demonstrator in medicine.

The following men from the teaching staff have received commissions in the Medical Officers Reserve Corps:

Dr. R. H. Boots,
Dr. D. Hartin Boyd,
Dr. Ewing W. Day,
Dr. A. W. Duff,
Dr. R. M. Entwisle,
Dr. Wade Carson,
Dr. S. K. Fenollosa,
Dr. J W. Fredette,
Dr. H. C. Flood,
Dr. Carl Goehring,
Dr. J. B. Gold,
Dr. J. P. Griffith,
Dr. J. L. Gilmore,
Dr. R. T. Hood,
Dr. F. H. Harrison,
Mr. J. Garfield Houston,
Dr. T. D. Jenny,
Dr. H. S. Kenny,
Dr. F. V. Lichtenfels,
Dr. George C. Johnston,
Dr. M. B. Magoffin,
Dr. C. H. Marcy,
Dr. E. W. Meredith,
Dr. H. T. Price,
Dr R. V. Robinson,
Dr. David Silver,
Dr. H. W. Stevens,
Dr. W. C. White,
Dr. E. E. Wible.

THE WAR AND NAVY DEPARTMENTS AND THE COAST AND GEODETIC SURVEY

AN executive order has been issued transferring to the service and jurisdiction of the War Department and the Navy Department certain vessels, equipment and personnel of the United States Coast and Geodetic Survey. It reads as follows:

> In accordance with the authority vested in me by the "Act to temporarily increase the commissioned and warrant and enlisted strength of the Navy and Marine Corps and for other purposes," approved May 22, 1917, I Woodrow Wilson, President of the United States of America, do hereby declare that a national emergency exists and do direct that there be transferred to the service and jurisdiction of the Navy Department for temporary use the following vessels, including equipment and personal other than commissioned officers thereof: *Surveyor, Isis, Bache.*
>
> Also there shall be transferred to the service and jurisdiction of the Navy Department the following named persons now part of the commissioned personnel of the Coast and Geodetic Survey:
>
> William E. Parker,
> Nicholas H. Heck,
> Clifford G. Quillian,
> Paul C. Whitney,
> Francis H. Hardy,
> Raymond S. Patton,
> Gilbert T. Rude,
> Robert F. Luce,
> Thomas J. Maher,
> Francis G. Engle,
> Leon O. Colbert,
> Harry A. Seran,
> Paul M. Trueblood,
> Richard R. Lukens,

Arthur J. Ela,
Arthur Joachims,
Harold A. Cotton,
Alfred L. Giacomini,
George C. Mattison,
Frits C. Nyland,
Eustace S. Walker,
Harrison R. Bartlett,
William V. Hagar,
Kenneth T. Adams,
Raymond V. Miller,
Frederic L. Peacock,
Ray L. Schoppe,
Conrad T. Bussell,
Leroy P. Raynor,
Gardiner Luce,
Lyman D. Graham,
Stanley T. Barker,
Leo C. Wilder,
Paul V. Lane,
Wilmer O. Hinkley,
George H. Durgin,
Charles K. Green,
George L. Bean.

Also there shall be transferred to the service and jurisdiction of the War Department, and I do hereby appoint and direct that they be commissioned and ordered to active duty as of date of this order, in the Officer's Reserve Corps in the grades set opposite their names, the following named persons now part of the commissioned personnel of the Coast and Geodetic Survey:

John T. Watkins, captain, U. S. R.,
Carey V. Hodgson, captain, U. S. R.,
John H. Peters, captain, U. S. R.,
John D. Powell, first lieutenant, U. S. R.,
Isaiah M. Dailey, first lieutenant, U. S. R.,
Otis W. Swainson, first lieutenant, U. S. R.,
George D. Cowie, first lieutenant, U. S R.,
Ernest E. Reese, first lieutenant, U. S. R.,
Frank S. Borden, first lieutenant, U. S. R.,
Max Steinberg, first lieutenant, U S. R,
Harry T. Kelsh, Jr, first lieutenant, U. S. R.,
Ernest W. Eickelberg, first lieutenant, U. S. R.
Arthur S Hallberg, first lieutenant, U. S. R.,
William H. Clark, first lieutenant, U. S. R.,
Bert C. Freeman, first lieutenant, U. S. R.,
Raymond A. Wheeler, second lieutenant, U. S. R.,
Andrew C. Witherspoon, second lieutenant, U. S. R.,
Herbert R. Grummann, second lieutenant, U. S. R.,
Roland K. Bennett, second lieutenant, U. S. R.,
Max O. Witherbee, second lieutenant, U. S. R.,
Payson A. Perrin, second lieutenant, U. S. R,
Aaron L. Shalowitz, second lieutenant, U. S. R.,
Roland D. Horne, second lieutenant, U. S. R.,
Robert J Hole, second lieutenant, U. S. R.,
Frederick E Joekel, second lieutenant, U. S. R,
Harrold W. Pease, second lieutenant, U. S. R.,
Benjamin Galoe, second lieutenant, U. S. R.,
John W. Cox, second lieutenant, U. S. R.,
George R. Hartley, second lieutenant, U. S. R.,

Also there shall be transferred to the service and jurisdiction of the War Department, and I do hereby appoint and direct that they be commissioned and ordered to active duty as of date of this order in the Officer's Reserve Corps in the grades set opposite their names, the following named persons now part of the personnel of the Coast and Geodetic Survey:

Edmund P. Ellis, captain, U. S. R.,
James W. McGuire, captain, U. S. R.,
Earl F. Church, first lieutenant, U. S. R.,
Oscar S. Adams, first lieutenant, U. S. R.,
Percy B. Castles, first lieutenant, U. S. R.,
Charles A. Mourhess, first lieutenant, U. S. R.,
Walter D. Lambert, first lieutenant, U. S. R.,
Walter N. McFarland, second lieutenant, U. S. R.,
S. L. Rosenberg, second lieutenant, U. S. R.,
H. S. Rappleye, second lieutenant, U. S. R.

The War and Navy Departments shall return to the service and jurisdiction of the Department of Commerce any or all of the material or personnel of the United States Coast and Geodetic Survey transferred by this order when directed by me so to do.

WOODROW WILSON

THE WHITE HOUSE,
24 September, 1917

SCIENTIFIC NOTES AND NEWS

PLANS are under way for the Pittsburgh meeting of the American Association for the Advancement of Science from December 28 to January 2. The Carnegie Institute, the Carnegie Institute of Technology and the University of Pittsburgh are uniting in preparing to entertain the association. Dr. W. J. Holland, director of the Carnegie Museum, is chairman of the committee on arrangements, and S. B. Linhart, secretary of the University of Pittsburgh, is secretary of the committee. Secretaries of affiliated societies and of other organizations meeting at this time are requested to send to the secretary as soon as possible the approximate number of members of each organization who expect to attend; the time for which meetings are to be arranged; also any social functions which will be included in their plans; and also whether lantern or moving picture equipment will be required for any of these meetings. Information in regard to entertainment, hotel rates, etc., can be secured from the secretary.

THE Bell Memorial, erected in honor of Alexander Graham Bell and his invention in 1874, of the telephone, was unveiled on October 21, at Brantford, by the Duke of Devonshire, governor general of Canada. Mr. Bell took part in the ceremonies. The memorial is the work of W. S. Allward of Toronto. It is on the Bell homestead, dedicated as the Alexander Graham Bell gardens. W. F. Cockshutt, M.P., originator of the plan, and president of the Bell Memorial Association, described Mr. Bell's work resulting in the sending of the first message over a real line in 1875 between Brantford and Paris, Ont.

THE Albert Medal conferred recently on Mr. Orville Wright by the Royal Society was presented to him by Lord Northcliffe on October 27.

TEMPORARY Brigadier-General Auckland Campbell Geddes, M.D., professor of anatomy in McGill University, has had conferred on him the honor of Knight Commander of the Order of the Bath. Dr. Geddes is now director of recruiting in England.

IN the department of chemical engineering of the University of Michigan all but one member of the faculty has left for active service. Every effort made by the university to replace them temporarily proved unavailing, owing to the unprecedented demand for men in this branch. The situation became so acute that several manufacturing concerns of the state, who employ expert chemical engineers, and the Michigan Agricultural College came to the aid of the university and it opens with a complete staff in this department. Dr. C. D. Holley, of the White Lead and Color Works, of Detroit, will act as head of the department during the absence of Professor A. H. White. Professor W. Platt Wood, of the chemical engineering faculty of the Michigan Agricultural College, has also been given leave of absence for the entire year. In addition the university has secured the services of J. C. Brier, of the Holland, Michigan, Chemical Company, and C. F. Smart, of the United States Graphite Company, of Saginaw.

A DIVISION of the Food Administration under the direction of Charles W. Merrill, of San Francisco, has been created to cover the chemicals involved in the production and conservation of foods. This division will cooperate with the other chemical committees of the government in their activities looking to the control and allocation of chemicals used as insecticides, fertilizers, and in refrigeration and other preservative methods.

SINCE the opening of the war Professor John Zeleny of the University of Minnesota has been engaged in perfecting devices for submarine detection, and is serving on a board for making practical tests at the submarine base at New London of other devices which have been submitted to the government for the detection of submarines. This work is still in progress.

DEAN GEORGE B. FRANKFORTER, of the school of chemistry of the University of Minnesota, and a member of the research committee of the Minnesota Public Safety Commission, has been commissioned major in the ordnance department of the army and will be given a leave of absence to attend to the duties of his new position.

PROFESSOR CHARLES W. COBB, associate professor of mathematics in Amherst College, has been granted leave of absence for one year to enter the aviation work of the government. He will hold a position in the Bureau of Instruction that supervises the teaching in the eight ground schools for aviators.

MAJOR DANA H. CRISSY, for four years professor of mathematics at West Point, has been appointed commandant of the government school of aeronautics at Princeton.

DR FRANK C. HAMMOND, who is connected with the Samaritan Hospital, has been appointed a member of the board of health of Philadelphia to serve during the absence in France of Dr. Alexander C. Abbott, who entered the Army Medical Corps several months ago.

WILLIAM H. WARREN, professor of chemistry in Wheaton College, Norton, Mass., and captain in the Quartermaster Corps, United States Reserve, has been placed on active duty and stationed at Camp Hancock, Augusta, Ga.

PROFESSOR GEORGE C. WHIPPLE, of Harvard University, and Professor C.-E. A. Winslow, of the Medical School of Yale University, have returned from Russia, where they were members of the American Red Cross Mission to assist in the sanitary survey.

PROFESSOR WALLACE C. SABINE, Harvard exchange professor at Paris last year, has returned to America.

PROFESSOR DR. THEODORE KOCHER, chief surgeon of the Inselspital, Berne, Switzerland, and professor at the medical faculty of the University of Berne, died on July 27.

UNIVERSITY AND EDUCATIONAL NEWS

THE teaching hospital of the University of Nebraska college of medicine was dedicated with appropriate ceremonies on October 17, the principal speaker being Chancellor Avery of the university. The new structure, now in full operation with a capacity of 119 beds, was made possible by three legislative appropriations, $150,000 for the building; $65,000 for equipment and $100,000 for a biennial maintenance.

PROFESSOR HENRY C. ANDERSON, of the mechanical engineering department, of the University of Michigan, who has been on leave of absence for the past two years, has been appointed head of the department in place of Professor John R. Allen, who resigned to accept the deanship in the college of engineering at the University of Minnesota.

PROFESSOR C. F. CURTIS RILEY, who has been in charge of the department of biology at the State Normal College, Milwaukee, Wisconsin, for the past four years, has been appointed special lecturer in animal behavior, in the department of forest zoology, at the New York State College of Forestry at Syracuse University.

DR. L. G. ROWNTREE, of the University of Minnesota, has declined the deanship of the Illinois school of medicine. His salary at Minnesota has been increased to six thousand dollars and an additional appropriation has been made for the further development of his department of medicine.

DR. CARL ROSENOW (Ph.D., Chicago '17), and Dr. Jacob Kantor (Ph.D. '14, Ph.D. '17, Chicago) have been appointed instructors in the department of psychology of the University of Chicago.

AT the college of medicine of the University of Nebraska Dr. Maurice I. Smith, for several years connected with the department of pharmacology at the University of Michigan, has been placed in charge of the department of pharmacology. Mr. J. A. Kittleson, of the University of Minnesota, has accepted the position of assistant professor of anatomy and Dr. S. A. Rubnitz has been made instructor in biochemistry.

AT Queen's University, Kingston, Canada, E. Flammer, Ph.D. (Harvard), has been appointed assistant professor of physics; O. F. S. Smith, M.Sc. (Pennsylvania State) has been made lecturer in the same department. In the department of geology, Kirtley F. Mather, Ph D. (Chicago), has been promoted from associate professor to professor of paleontology.

DR. OLAF BERGEIM of the department of physiological chemistry of Jefferson Medical College, has been promoted to associate in that department.

DR. A. E. SHIPLEY, Master of Christs College, Cambridge University, has succeeded to the office of vice chancellor of the University, in succession to the Rev. T. C. Fitzpatrick, president of Queen's College.

DISCUSSION AND CORRESPONDENCE

ALGONKIAN BACTERIA AND POPULAR SCIENCE

THERE are two points in Dr. R. S. Breed's communication of September 7 entitled "Popular Science" to which I would like to call attention.

First, my obvious error in the citation from page 292 of *The Scientific Monthly*. How this *non sequitur* slipped through my reading and that of Dr. I. J. Kligler I do not know. It is a wholly illogical statement which is corrected and replaced in the following sentence of my recently published work "The Origin and Evolution of Life," where it reads (p. 85) as follows:

> The great geologic antiquity even of certain lower forms of bacteria which feed on nitrogen is proved by the discovery, announced by Walcott in 1915, of a species of pre-Paleozoic fossil bacteria attributed to ''*Micrococcus*,'' but probably related rather to the existing *Nitroso coccus*, which derives its nitrogen from ammonium salts.

Perhaps the words "rendered probable" would be more accurate than the word "proved'' in the sentence as it stands.

As to the second point, Dr. Breed raises the question whether the fossil markings described by Dr. Walcott in the fossil limestone are actually bacteria. On this point there can be no doubt whatever. Walcott reproduced for comparison an illustration of *Micrococcus* from the Encyclopedia Britannica and referred the Algonkian bacteria to *Micrococcus* sp. undt = species undetermined.

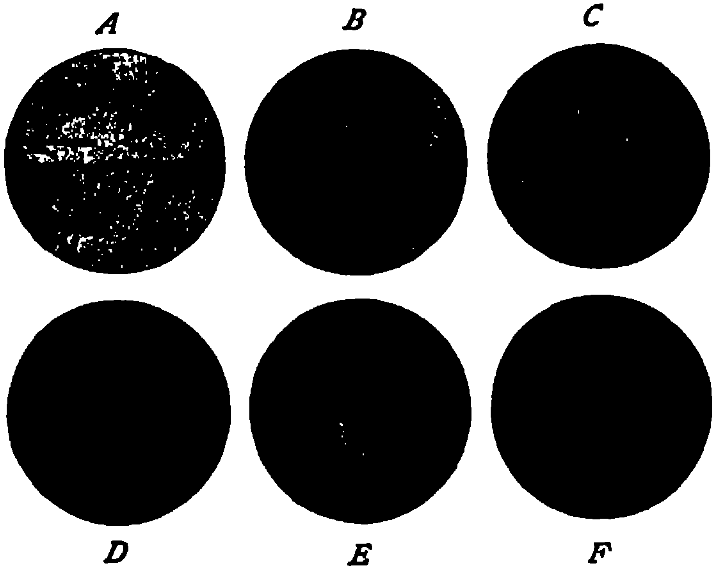
At my request this very interesting determination by Walcott was taken up by Dr. Kligler, and after a careful investigation he made the series of special preparations of bacteria which are reproduced (*B–F*) in the accompanying figure together with parts of Walcott's two figures (*A*). Dr. Kligler came to the conclusion that the Algonkian type was closer to the existing *Nitroso coccus*, which derives its nitrogen from ammonium salts, than to *Micrococcus*. The similarity between the Algonkian bacteria (*A*) and some recent forms of nitrifiers (*B, C*) is shown in the comparison of the parts indicated by arrows in the figure.

A comparison of these fossil and recent preparations appears to bear out my statement, made on the authority of Dr. Kligler, that

> The cell structure of the Algonkian and of the recent *Nitroso coccus* bacteria is very primitive and uniform in appearance, the protoplasm being naked or unprotected.

Here the word "relatively" might have been inserted.

My entire chapter on bacteria was prepared with the kind cooperation of Dr. I. J. Kligler. Walcott's discovery was cited as indicative of the antiquity of bacteria and my statement was intended to be hypothetical and not categorical. Dr. Breed may be correct in the assumption that the fossil bacterial impressions represent forms related to the denitrifying bacteria and not to the nitrogen fixers or nitrifiers, as Dr. Kligler has suggested. The acceptance of his view would strengthen rather



than weaken the general thesis that bacteria represent a very ancient form of life, for the denitrifying bacteria are generally conceded to be higher in the scale of bacterial life than either the nitrogen fixers or the nitrifiers. If organisms related to the higher denitrifiers existed in the Algonkian, is it not reasonable to assume that simpler forms existed earlier in geologic time? In other words, the hypothetical point as to whether the Algonkian bacteria represent forms related to the nitrifiers or the denitrifiers is immaterial to the conclusion regarding the great antiquity of bacteria.

As to the matter of "popular science" in general the popularizer always runs into danger as soon as he leaves his own special field of research. No one is more conscious of such pitfalls than myself; it is difficult enough to avoid pitfalls in one's own field without venturing into others. At the same time I feel very strongly that little or no progress will be made in the principles of biology (as distinguished from discoveries in special fields of research) unless biologists have the courage to venture occasionally into the fields of physics, chemistry, physiology and zoology in order to look at life from a broader and more distant point of view. Such an attempt I have made in the Hale Lectures which Dr. Breed cites and which now appear in a somewhat more carefully considered form in "The Origin and Evolution of Life." On every topic I have sought and found the cooperation and criticism of other workers—in physics of Pupin, in chemistry of Gies and Clarke, in zoology of Wilson, in astronomy of Hale and Russell, in botany of Goodspeed and Howe, and many others. Although every effort has been made to guard against errors, it may be that others have slipped in, but I take it for granted that specialists will not mistake a popular work for a work of reference nor imagine that I presume to speak with the authority of a specialist in any field but my own.

Henry Fairfield Osborn

THE TEACHING OF OPTICS

The recent discussion in the columns of Science as to the best method to be followed in presenting the fundamental laws and concepts of mechanics to the student has been followed with much interest by teachers of physics. To the writer it seems equally important that attention be directed to another branch of physics, and the question raised as to whether there should not be a radical change in our methods of introducing the student to the subject of optics.

It is generally conceded by those qualified to speak with authority that the establishment of the electromagnetic theory of light represents one of the greatest achievements of modern science. Yet in spite of the far-reaching importance of this principle, the average student who has completed his college course in general physics, or even in many cases more advanced special courses, is entirely unfamiliar with the meaning or the significance of the electromagnetic theory. *This need occasion no surprise, however,* in view of the methods commonly employed at present in teaching the subject of optics. For certainly a text-book which either does not mention the electromagnetic theory of light or relegates it to a footnote or inconspicuous paragraph is hardly calculated to inspire the student with any great respect for that theory. This criticism applies, not to our text-books alone, but with equal force to the ordinary lecture course.

In order to investigate the justice of this claim that one of the most important principles of modern physics is almost entirely ignored in our present system of teaching and is seldom accorded the attention its importance demands, the writer recently made a careful examination of ten representative text-books of physics, all of them published within the past decade and including practically all, so far as known to the writer, which are very extensively used in our American colleges and universities at the present time. As a result of this examination it was found that in three of these text-books no reference whatever is made to the electromagnetic theory; three other authors content themselves with a bare mention of the theory;

in four of the books an attempt is made to state a few of the more important consequences of the theory, but in practically every case this discussion is limited to one or two paragraphs, either at the very end of the book or at the end of the subject of electricity. (It is a striking fact that nearly all of these authors who deem the electromagnetic theory of light worthy of any comment at all, discuss it, not where we would naturally look for it—under the head of "Light"—but under "Electricity," and then proceed calmly to ignore it when "Light" is taken up!) In only one of the text-books examined is there any attempt at the outset to make clear to the student what light really is or to bring out the fact that there is an intimate connection between optical and electrical phenomena. In not one of the books is the electromagnetic theory made the basis of the treatment of light.

In most of our text-books there is a chapter entitled "The Nature of Light" or "Theories of Light," in which pains are taken to relate the triumph of the wave theory of light over the corpuscular theory, but in practically every case the author stops short before coming to the *crux* of the whole matter; there is no suggestion as to what kind of waves light waves are. This is a question which is sure to occur to the student, if he be of a normally inquiring turn of mind, but his perplexity is left unanswered. Certainly no teacher would think of omitting from a discussion of sound waves an explanation of what kind of waves sound waves are; yet this is the common procedure when light waves are discussed.

Only two ideas suggest themselves as reasons for the common neglect of so important a principle; either the electromagnetic theory is thought to be not yet sufficiently well established to find a place in our text-books, or it is thought to be too difficult for the average student to grasp. As to the former, few will question the fact that the theory has been abundantly verified from every point of view and has been firmly established long enough to justify its occupying a prominent place in our text-books and lectures.

The opinion is widely prevalent, however, that the electromagnetic theory presents difficulties so great as to be insuperable for the average college undergraduate. While it may be admitted that the mathematical development of Maxwell's equations and their application to the various cases of reflection, refraction, and dispersion are decidedly beyond the grasp of the average sophomore, yet it is surely possible to present the essentials of the theory in non-mathematical form, and to discuss its more important consequences, as was attempted by the writer in a recent number of *The Scientific Monthly*. As to the vagueness which many feel to be inherent in any attempt to picture a light wave on the electromagnetic theory, we may remark that our conception of an electromagnetic wave is precisely as definite as our ideas of an electric or magnetic field.

It is true that many of the phenomena of light can be given a very simple explanation in terms of the so-called "elastic solid theory," but whatever the advantages offered by the conventional mode of presentation, they are more than counterbalanced by the simple fact that in the light of our present knowledge it is not true to the facts. Certainly our aim in teaching should be to inculcate a knowledge of reality, not of convenient fictions with regard to the processes of nature. In more than one of the text-books under consideration frequent reference is made to the "vibrating ether particle" which it is assumed serves to transmit a light wave. It would be interesting to know just what sort of a thing an "ether particle" is conceived to be, but quite apart from the absurdity involved in the use of such a term, there can be no doubt that the conception which the expression "vibrating ether particle" tends to fix in the mind of the student is erroneous and misleading. And so with certain other of the stock phrases we have become accustomed to use in dealing with the phenomena of light.

The ideal course in optics, in the opinion of the writer, should be based from first to last upon the electromagnetic theory. A chapter on electromagnetic waves under the head of "Electricity," in which the nature and chief properties of these waves and their application in wireless telegraphy are briefly discussed, paves the way for a more thoroughgoing discussion of these waves under the head of "Light." From the beginning of his study of light to the end the student should never be allowed to lose sight of the fact that light is essentially an electromagnetic phenomenon; each branch of the subject should be developed on the basis of this theory; and the intimate relationship between the optical properties of a body and its electrical properties should be constantly stressed.

There is perhaps no other branch of science in which the disparity between the point of view of the investigator and that of the elementary student is quite so great as in optics. The modern worker in this field thinks of the phenomena of light in terms of electromagnetic waves and the behavior of electrons under the influence of these waves; to the student, on the other hand, the ideas which form the working basis of the investigator in his researches are meaningless, because he has no knowledge of the theory upon which these depend or of the experimental facts which underlie them. It must be admitted that in all essentials the subject of light is taught to-day very much as it was taught fifty years ago; exactly as we might expect it to be taught if Maxwell had never lived and if the theory which we owe to him had never been suggested. It is to be sincerely hoped that the near future may witness a radical change in this respect, and that those principles which serve as the groundwork of the modern physicist and which guide him in his researches may be correspondingly stressed in our attempts to present the essential facts of optics to the student.

David Vance Guthrie

Louisiana State University

TRANS-PACIFIC AGRICULTURE

Whatever the merits of the particular case, the coincidence between the design called House of Tcuhu in Arizona and the Minoan Labyrinth in Crete, described in Science for June 29, page 677, is of interest as an illustration of a large class of facts in need of the more general scientific consideration that Professor Colton bespeaks. The statement, "There are three possible explanations of the coincidence," needs to be extended. American origin and prehistoric transportation to the old world is a fourth possibility as worthy of consideration as pre-Columbian transfer from the old world to America, introduction with the Spanish conquest, or independent origins in the two hemispheres.

Several cultivated plants of American origin appear to have been carried across the Pacific in prehistoric times, such as the coconut palm, the sweet potato, the bottle gourd, the yam bean, and the Upland species of cotton. The same name for sweet potato, *cumara* or *kumara,* is used by the Indians of the Urubamba valley of southern Peru and by the Polynesians, and other plant names are similar. Moreover, since the migrations of the prehistoric Polynesians extended across the Pacific and Indian Oceans, from Hawaii and Easter Island to New Zealand and Madagascar, it is not unreasonable to look for traces of communication with ancient America in the early civilizations of Asia, Africa or the Mediterannean region.

Agriculture is the primary, fundamental art of civilization, and the evidence of the cultivated plants is the most concrete of any that bears upon the question of prehistoric communication between the more civilized peoples of the two hemispheres. No such significance can be ascribed to the contacts or migrations of non-agricultural people across Bering Strait or the Aleutian Islands. For ethnologists, it may be easy to assume that agriculture had separate beginnings in the old world and the new, but botanists are unable to believe that the same genera and species of cultivated plants originated independently in the two hemispheres, or that they were carried across the Pacific without human assistance.

Peru undoubtedly was the chief center of domestication and distribution of cultivated plants in America, and in view of this must be considered also as a point of convergence in attempting to trace back to their origins other features of primitive civilization. The large number of domesticated plants and the high development of agriculture in Peru testify even more forcibly than the succession of different styles of Cyclopean architecture to the presence of large agricultural populations in the valleys of the eastern Andes through long periods of time. The ancient reclamation works of Peru challenge comparison with anything that was accomplished in Egypt or Assyria. How far the influence of the ancient Peruvian civilization may have extended in America or elsewhere is a question to which attention may well be given. Pressure of population is a compelling force in the domestication of plants and the development of intensive agriculture, as well as a cause of migration to unoccupied regions. The essential unity of physical types and of agricultural and other arts among the more advanced peoples of ancient America is to be taken into account, as well as the indications of early trans-Pacific communication of agricultural arts and cultivated plants.

It is important to consider all of the archeological and ethnological agreements or coincidences, since these may make it possible to determine the stage of development of civilization in which the prehistoric communication occurred. Whether any particular agreement of words, traditions, or "culture elements" is of real significance is not likely to be determined until such data are brought into relation with facts of other kinds. From the House of Tcuhu in Arizona to the Labyrinth of Minos in Crete, by the way of Peru and Polynesia, is a long journey, but it covers the most practicable routes for the gradual extension of primitive agricultural peoples. That the labyrinth design originated independently in the two hemispheres is as hard to believe as that different people should have identical thumb-prints. If post-Columbian transfer from the Mediterranean region can not be shown, the trans-Pacific route from America to the old world should be considered.

O. F. Cook

Bureau of Plant Industry,
U. S. Department of Agriculture,
Washington, D. C.

BENJAMIN FRANKLIN AND THE STRUGGLE FOR EXISTENCE

The extent of Benjamin Franklin's mailing address mentioned in the contributions of Dr. Hussakoff and Professor Woodruff in recent issues of Science is equalled only by the breadth of Franklin's scientific and other interests.

Just as Darwin and Wallace arrived at the theory of natural selection by reading Malthus's essay on the "Principle of Population" so Malthus was prompted to write his essay by reading a very brief contribution of Franklin published in 1751 "Concerning the Increase of Mankind."

Franklin's clear observations on the peopling of the New World led him very surely to the notion of a struggle for existence and the pressure of population on the environment. On these two points Franklin writes as follows:

> There is, in short, no bound to the prolific nature of plants and animals but what is made by their crowding and interfering with each other's means of subsistence. Was the face of the earth vacant of other plants, it might be gradually sowed and overspread with one kind only, as, for instance, with fennel, and were it empty of other inhabitants, it might in a few ages be replenished from one nation only, as, for instance, with Englishmen. Thus there are supposed to be now upwards of 1,000,000 of English souls in North America (though it is thought that scare 80,000 have been brought over sea) and yet, perhaps, there is not one the fewer in Britain.

Regarding the pressure of population, Franklin says in this same essay that America is

> chiefly occupied by Indians who subsist mostly by hunting. But as the hunter, of all men requires the greatest quantity of land from whence to draw his subsistence, the Europeans found America as fully settled as it well could be by hunters.

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SCIENTIFIC BOOKS

The Manufacture of Sulphuric Acid and Alkali with the Collateral Branches. A Theoretical and Practical Treatise. By GEORGE LUNGE, Ph.D. Fourth edition. *Supplement to Volume I. Sulphuric and Nitric Acid.* New York, D. Van Nostrand Company. 1917. Pp. xii + 347. Price $5.00.

This volume represents rather a new idea in bringing books up to date. The last edition of Lunge's great treatise on sulfuric acid was published in February, 1913. The great advances made along this line, as along almost every line of chemical technology, in the past four years have rendered no little material in the book quite out of date. At the same time a new edition of such a large and expensive work seemed hardly called for. The author and his publishers have found an excellent solution of the problem with which they were confronted by issuing this supplement. All the new matter is printed consecutively with reference to the paging of the original, quite like a volume of footnotes. While the book thus necessarily lacks literary form, to the technological student it is unexpectedly readable, furnishing, as it does, a complete review of the progress of the acid industry for the past four years.

On looking through the book one is struck with the immense amount of work that has been done since the opening of the war, most of it directly occasioned by the inexorable demand for explosives. Sir William Crookes little dreamed, when a few years ago he delivered his now classic address on the wheat supply of the world, that he was making such a world-wide war as the present possible. He saw the peoples of the world rapidly becoming wheat-eaters; the possible wheat lands of the world largely utilized; the only possible source of increased wheat supply a greatly increased production per acre; this increased production only attainable by greatly increased quantities of nitrogen fertilizer; and the only important source of fertilizer, the Chile saltpeter beds, facing exhaustion in a few decades. The clear statement of the problem naturally set chemists at its solution, which of course involved methods of utilizing the inexhaustible supply of atmospheric nitrogen for the manufacture of nitric acid and ammonia. But nitrates are as indispensable for munitions of war as for fertilizer. Ten years ago the other nations would have been helpless at the hands of Germany as soon as their first meager supply of explosives had been shot away, since Germany had foreseen this shortage and long ago "stocked up." On the other hand, had the Chilean niter beds sufficod for the Allies until Germany's supply was exhausted, she would have been at their mercy. Thanks to the stimulus of Sir William Crookes's address, as far as explosives go, the war can continue indefinitely, but after the war the farmer and the wheat-eaters will come to their own, as Sir William intended they should.

The problem of combining atmospheric nitrogen had been commercially solved a few years before the war opened. Lime, saltpeter and nitric acid were being manufactured at Notodden in Norway, and the Rjukanfos, with its 250,000 horse-power, was largely ready for utilization in 1913. Calcium cyanamid was being made at half a dozen plants in different countries, and from this ammonia was easily obtained. The Haber process for combining nitrogen and hydrogen into ammonia was probably being worked commercially in Germany early in 1914, and processes for oxidizing ammonia into nitric acid were becoming available. All of these and numerous lesser processes sufficed to free Germany from dependence on the Chile niter, and the Allies have profited no less.

Equally necessary for munitions is concentrated sulfuric acid, which indeed is demanded in almost every chemical industry, and while the advances in its manufacture have been less striking than has been the case with nitric acid, fully two thirds of the volume is taken up with its progress. These developments have been divided between improvements in the contact process, and the old lead-chamber process, and in the concentration of the chamber acid.

It will interest technologists to know that the book contains at least brief descriptions of practically all patents bearing on the subject during the period covered by the book, and the information regarding progress in Germany during the war is probably fuller than has elsewhere appeared.

The book contains a full author and subject index, which is particularly valuable, since it includes references both to the original fourth edition and to the supplement.

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AN ENCYCLOPEDIA OF PEACHES

The Peaches of New York. By U. P. HEDRICK, assisted by G. H. HOWE, O. M. TAYLOR and C. B. TUBERGEN. New York Agricultural Experiment Station, Geneva, 1917.

Two comparisons come easily to mind on opening Professor Hedrick's "Peaches of New York." The first is with Poiteau's "Pomologie Française"; the second is with Professor Beach's "Apples of New York."

The beauty of the ripened fruit has always appealed to persons of literary taste and esthetic sensibility, and such persons have often wished to make permanent record of the delights of their gardens and orchards. There have been many notable books, covering more than a century of time, extra-illustrated with colored plates of fruits. The "Pomologie Française" may be mentioned as one of the best early examples of such work.

It might not be much to expect that the "Peaches of New York" would excel any book of a hundred years ago, and yet this standard has been so rarely reached that it is a compliment to say that any one anywhere approaches it. This new book, however, surpasses the old in two fundamental particulars, in the excellence of its plates and in the scientific assemblage of taxonomic data.

Professor Beach's "Apples of New York" comes into the comparison as being the great beginning of this notable series, which now includes the "Grapes of New York," "Plums of New York," and "Cherries of New York." It will be seen that the technical processes of color-photography and printing as applied to this line of work have been greatly improved, even in these last few years, for though the photographing of peaches is much more difficult than the photographing of apples, the color plates of the present volume are emphatically superior. And this point will bear some emphasis, considering how important such plates are as a means of description, and considering that the accurate description of varieties is exactly the main objective of the series.

One must see, too, that the science of systematic pomology has made great progress since the days of Poiteau and Turpin. There have been catalogues of varieties with descriptions and lists of synonyms of course for nearly 200 years, but as a matter of fact the science of systematic pomology is practically a development of the last dozen years. It is, moreover, as yet almost an exclusively American science, having been developed largely by the critical pomological workers in the experiment stations and the United States Department of Agriculture. Professor Hedrick, with his quite unusual facilities and his corps of trained assistants, has been able to bring these modern methods of systematic study to a high degree of perfection. It is not too much to say that, in breadth of view, bibliographic comprehensiveness, and critical examination of detail it would be hard to find better work anywhere in the older fields of taxonomic science.

Emphasis is placed upon the systematic or encyclopedic features of the work, for these are certainly the most important. There are dozens of books and hundreds of bulletins where the reader can more easily find a discussion of how to grow peaches, but the present work will long be the first reference for all those who want the last word on the description or nomenclature of varieties.

The title is of course a brazen misnomer. The book is not limited to the peaches of New York, and probably was never intended to cover any such narrow view. It is a book for the whole United States and the peach-growing portions of Canada. In fact one might better call it "Peaches of the World," for it will doubtless be consulted as widely as Poiteau's fine old book written over seventy years ago and called by a less provincial name, the "Pomologie Française."

F. A. W.

SPECIAL ARTICLES

COMPARISON OF THE CATALASE CONTENT OF THE BREAST MUSCLE OF WILD PIGEONS AND OF BANTAM CHICKENS

It is now generally accepted that the energy for muscular work is derived from oxidation of the food materials, although physiologists are not agreed as to the means by which the body accomplishes this oxidation at such a low temperature as 39° C., the temperature of the body.

The present investigation was carried out to determine if catalase, an enzyme which liberates oxygen from hydrogen peroxide or from an organic peroxide comparable in structure to hydrogen peroxide, is greater in amount in the breast muscles of wild pigeons accustomed to flying than it is in the breast muscle of bantam chickens not so accustomed; if the catalase content of the breast muscles of the pigeons would be decreased by decreasing the amount of work done by these muscles, and if it would be increased in the breast muscles of the chickens by increasing the amount of work done.

After several wild pigeons and bantam chickens had been washed until free of blood by the use of large quantities of 0.9 per cent. sodium chloride, as was indicated by the fact that the wash water gave no test for catalase, the breast muscles were removed and ground up separately in a hashing machine. One gram of this material was added to 50 c.c. of hydrogen peroxide in a bottle at 22° C., and as the oxygen gas was liberated it was conducted through a rubber tube to an inverted burette previously filled with water. After the volume of oxygen gas, thus collected in ten minutes, was reduced to standard atmospheric pressure the resulting volume was taken as a measure of the amount of catalase in the gram of material. It was found that one gram of the breast muscle of the wild pigeons liberated on an average, 98 c.c. of oxygen, while that of the bantam chickens liberated only about 8 c.c., hence, the amount of catalase in the breast muscle of the wild pigeons is much greater than that of the bantam chickens.

Several wild pigeons were confined for three weeks in individual small cages so that they could not use their breast muscles in flying, while several bantam chickens were made to run and fly until they were almost exhausted once a day for fifteen days. The catalase of the breast muscles of these pigeons and chickens was determined as in the preceding. It was found that confinement decreased the catalase content of the breast muscles of the pigeons by about 40 per cent., while exercise increased that of the breast muscles of the bantam chickens by almost 25 per cent.

The fact that an increase or decrease in the amount of work, and hence in oxidation in a muscle, is accompanied by a corresponding increase or decrease in the amount of catalase, would seem to suggest that catalase may play a rôle in the oxidative processes of the body.

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CILIA IN THE ARTHROPODA

THAT cilia are absent in the Arthropoda is an assumption which has crept into our zoological literature. Thus, Adam Sedgwick in his "Student's Text-Book of Zoology," Vol. III., 1909, pp. 316–317, says: "These ducts in the female[1] retain a ciliated lining (Gaffron), the only known instance of the occurrence of a ciliated tract among the Arthropoda." Then again, we read in Parker and Haswell's "Text-Book of Zoology," Vol. I., (revised edition), 1910, p. 526, as follows: "Arthropods are also characterized by the almost universal absence of cilia." Kingsley, on page 357 of his revised edition of Hertwig's "Manual of Zoology," 1912, makes the following assertion concerning cilia in the Arthropoda: "The entire absence of cilia is noteworthy. Ciliated cells have never been found in arthropods." Still another zoologist, J. Arthur Thomson in the fifth, revised edition of his

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[1] Sedgwick is discussing ducts in the female reproductive organs of *Peripatus*.

"Outlines of Zoology," 1913, makes a similar remark. Thomson, in speaking of the characteristics of the Arthropoda, on page 281, says: "Ciliated epithelium is almost always absent."

While working on the structure of the male reproductive organs of certain Decapoda,[2] the author has found good examples of ciliated epithelium in the vasa deferentia of the following forms: the Pacific coast crayfish *Astacus leniusculus*, the Puget Sound hermit crab *Pagurus setosus*, the Atlantic coast lobster, *Homarus americanus*, and the spiny lobster of the California coast, *Panulirus interruptus*.

The vasa deferentia of these crustacea were fixed in various fluids (Hermann's, Flemming's, Bouin's and formaldehyde), and the section were cut 5 μ in thickness. These prepared sections formed the basis for the observations herein recorded. The author tried to tease out the living epithelial cells from the vas deferens of *Astacus leniusculus* in physiological salt solution, Ringer's solution as well as in the body fluids of the crayfish, with a view towards observing ciliary movement in the living cells, but along this line of experimentation little success was met with. In the first place, the heavy secretions of the vas deferens, coupled with the refraction of the cell structures, masks any clear-cut observations. Secondly, the cytoplasm of the epithelial cells is so frail that it goes all to pieces upon the application of the least amount of pressure. The writer had, therefore, to rely solely on the prepared slides. However, these epithelial cells are so distinctly and so characteristically ciliated in the fixed material, that they are very convincing and appear to allow of no other interpretation.

In all the forms mentioned the inner lining of the vas deferens consists of a layer of ciliated epithelium, which is made up mainly of columnar cells. This epithelium is more or less glandular in nature and manufactures a thick, viscid secretion that forms the spermatophoral pouches as well as the sperm-preserving fluid which is commonly found in the Decapoda.

In *Astacus leniusculus* the epithelial lining is more or less uniform throughout the vas deferent tube, while in the other forms it becomes somewhat modified.

In *Paragus setosus*, the epithelial cells become concentrated at one pole of the vas deferens and here they are very much elongated, columnar cells and bear fine examples of cilia. This region of the epithelium seems to be especially adapted for manufacturing the secreting fluid. The lining epithelium of the rest of the vas deferens tube consists of ciliated cuboidal cells.

In *Homarus americanus* the epithelium becomes convoluted in numerous places of the distal end of the vas deferens, thus affording a larger secreting surface. Wherever these convolutions occur, the cells are usually larger, and contain longer cilia than in other regions. Herrick[3] who has made an extensive study of the lobster does not mention ciliated epithelium in the vasa deferentia. In good preparations, the ciliated epithelium is so distinct that one is able to make clear microphotographs of these structures without any difficulty.

In the spiny lobster *Panulirus interruptus*, the finest examples of ciliated epithelium were found. In this crustacean the vas deferens is very long and is lined by an inner layer of ciliated columnar epithelial cells. At one point in the vas deferent tube this epithelial lining dips inward into the cavity of the tube and becomes profusely convoluted into a mass of simple tubular glands. In cross sections, some of these glands may be seen cut across to show the central lumen completely surrounded by the epithelial cells. In such cases, the long cilia are very distinctly seen extending from the free surfaces of the cells into the interior of the lumen.

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[2] A fuller account of these studies is soon to appear in the publications of the Puget Sound Marine Station, Vol. No. 26, under the title of "Male Reproductive Organs of Decapoda, with Special Reference to Puget Sound Forms."

[3] Herrick, F. H., "Natural History of the American Lobster," Bull. U. S. Bur. of Fisheries, Vol. XXIX., 1909.

The cilia described in these Decapoda conform in every respect to all authentic descriptions and pictures of cilia which have come under the writer's observation. In many cases, they are short and straight. In other instances they are long and wavy. In still other examples they cluster together to form the so-called brushes. Furthermore, the cilia in all the cases mentioned spring from a well-defined border, and also contain the characteristic basal granules.

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RHYTHMIC BANDING[1]

The formation of Liesegang's rings, known sometimes as "rhythmic banding," is of interest to the geologist and biologist as well as to the chemist The color arrangement of agate is an excellent example of this phenomenon. Liesegang's original experiments dealt with the rhythmic precipitation of silver dichromate in gelatine. A solution of silver nitrate was poured on a solid gel containing dilute potassium dichromate. The precipitate of silver dichromate formed was not continuous but marked by gaps or empty spaces at regular intervals.

I found it possible to obtain distinct banding of silver dichromate in loosely packed flowers of sulphur. From this and other experiments it is evident that a gel is not absolutely necessary. In practise I found the best medium for sharply marked bands to be silicic acid gel. With this I secured remarkably crystalline banding of mercuric iodide, as many as forty bands in a test tube. Reduced gold in red, blue and green colloidal particles recurring in regular rainbow bands was obtained with a special silicic acid gel.

Basic gels made it possible to secure bands of cupric hydroxide merging into red and yellow forms of cuprous oxide. In a silicic acid gel of slightly basic reaction crystalline basic mercuric chloride formed in very distinct bands. The best banding in the absolute clearness of the gaps was that of copper chromate in a slightly basic gel.

Upon these experiments a new theory may be built. For illustration consider the copper chromate banding.

The gel contains a dilute solution of a chromate and above it in the tube a solution of a copper salt. The copper ions diffuse into the gel, meet the chromate ion and form a layer of insoluble copper chromate at the surface of the gel. The chromate ions immediately below this precipitation zone diffuse into this region now depleted of chromate ions and meet the advancing copper ions thus thickening the layer of copper chromate. According to Fick's law of diffusion the rate of diffusion is greatest where the difference in concentration of the chromate ions in two contiguous layers is greatest, that is, just below the front of this thickening band of copper chromate. As a result the region near the band decreases in concentration of the chromate ions faster than the space below. Finally the copper ions have to advance some distance beyond the band to find such a concentration of chromate ions that the solubility product of copper chromate may be exceeded and a new band formed. This repeats again and again. Of course if the copper ions were retarded sufficiently there would be time for the concentration of the chromate ions again to become uniform throughout the remaining clear gel and no gap would occur. Hence if the diffusion of the copper ions is retarded by any means the clear gaps decrease in depth—the bands are closer together. If copper ferrocyanide bands are formed in similar manner they almost merge after the first layer reaches a thickness of a few cubic centimeters. Yet they are distinct and agate-like. A precipitate of copper ferrocyanide greatly retards the diffusion of the ions that form it, hence we have here the proper condition to reduce the clear gaps to a minimum depth.

The complete paper with working directions and a full exposition of the theory will soon be published elsewhere.

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[1] Abstract of paper read at the Kansas City meeting of the American Chemical Society, April 12, 1917.

SCIENCE

FRIDAY, NOVEMBER 9, 1917

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THE STRUCTURE OF ATOMS AND THE EVOLUTION OF THE ELEMENTS AS RELATED TO THE COMPOSITION OF THE NUCLEI OF ATOMS.

II

The elements have thus been found to fall into two series: first, those of even, and second, those of odd, atomic number. Now, if the theory presented for the structure of the atoms is correct, then it should be possible to find some difference between the two series with reference to their properties. Since, however, this part of the theory refers specifically to the structure of the nuclei of the atoms, and not to the arrangement of the external or non-nuclear electrons, it is evident that this difference should not be found in those properties due to the external electrons, that is in the chemical or physical properties. On the other hand, the difference should be found in any properties inherent in the nucleus, and the only property, aside from mass and weight (from which our system has been developed), which has thus far been discovered, and which is due to the structure of the nucleus of the atom, is that of atomic stability. Thus, if an atom loses outer electrons, it does not change its atomic number, and therefore does not change to another element, but if it loses nuclear electrons, it does change its nucleus, its atomic number is changed, and the atom is said to disintegrate—that is, it changes into the atom of another element.

Our theory therefore indicates a probable general difference in stability between the even- and odd-numbered elements. A consideration of the radioactive elements indicates that those which have odd atomic numbers have either shorter periods, or else are at present unknown. Now unfortunately there is no known method of testing the stability of the elements of low atomic number, but it might seem, at first thought, that the more stable atoms should be the more abundantly formed, and to a certain extent this is undoubtedly true. If then, at the stage of evolution represented by the solar system, or by the earth, it is found that the even-numbered elements are more abundant than the odd, as seems to be the case, then it might be assumed that the even-numbered elements are on the whole the more stable. However, there is at least one other factor than stability which must be considered in this connection. The formula of the even-numbered elements has been shown to be nHe'. Now, since that for the odd-numbered elements is $nHe' + H_3'$ it is evident that if the supply of the H_3' needed by the elements was relatively small at the time of their formation, not so much material would go into this system, and this would be true whether the H_3' represents three atoms of hydrogen or one atom of some other element.[3]

In studying the relative abundance of the elements the ideal method would be to sample one or more solar systems at the desired stage of evolution, and to make a quantitative analysis for all of the 92 elements of the ordinary system. Since this is evidently impossible, even in the case of the earth, it might be considered that sufficiently good data could be obtained from the earth's crust, or the lithosphere. However, the part of the crust to which we have access is relatively so thin, and has been subjected to such far-reaching magmatic differentiation, and to such extensive solubility effects, that it seems improbable that the surface of the earth at all truly represents its composition as a whole. The meteorites, on the other hand, show much less evidence of differentiative effects, and undoubtedly represent more truly the average composition of our planetary system. At least it might seem proper to assume that the meteorites would

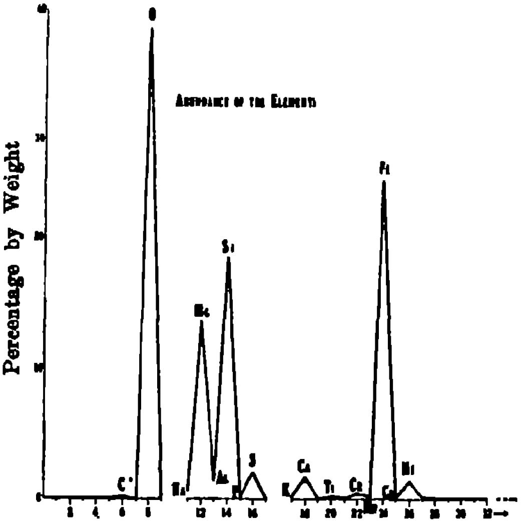

Fig. 2 The Periodic Variation in the Abundance of the Elements as the result of Atomic Evolution. The data are given for 125 stone meteorites, but the relations are true for meteorites in general. Note that *ten* elements of even atomic number make up 97.59 per cent. of the meteorites, and *seven* odd-numbered elements, 2.41 per cent., or 100 per cent. in all. Elements of atomic number greater than 29 are present only in traces.

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[3] With regard to the latter alternative, it is at least remarkable that the H_3 occurs 11 times in the system for the first 27 elements, while H_2 and H each occur only once, and it may also be mentioned that Fabry and Buisson have by interference methods determined the atomic weight of nebulium to be 2.7, and this they think indicates that its real atomic weight is 3. Also, Campbell has found that in the nebula N. G. C. Index 418, situated in the southern part of the constellation of Orion, the nebulium spectrum is found farther from the interior than that of helium, while the hydrogen spectrum extends out to a much greater distance still. This, he thinks, indicates that the atomic weight of nebulium lies between the values for hydrogen (1) and helium (4).

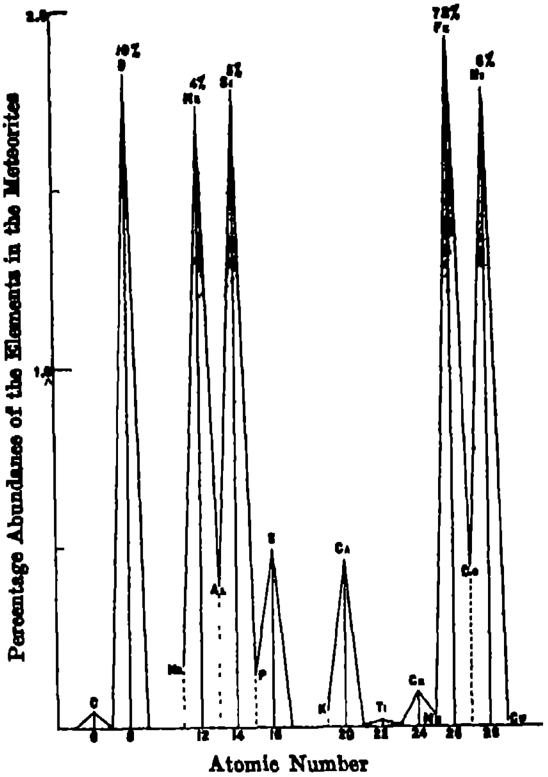

FIG. 3. The abundance of the elements in the meteorites. Every even-numbered element is more abundant than the two adjacent odd-numbered elements.

not exhibit any special fondness for the even-numbered elements in comparison with the odd, or, vice versa, any more than the earth or the sun as a whole, at least not unless there is an important difference between these two systems of elements, which is just what it is desired to prove. A study of the compilations made by Farrington, by Merrill, and by other workers of analyses of meteorites, has given some very interesting results.

The results show that in either the stone or the iron meteorites the even-numbered elements are very much more abundant than the odd. Thus in the iron meteorites there are about 127 times more atoms of even atomic number than of odd, while in the stone meteorites the even-numbered elements are about 47 times more abundant. If we average the 125 stone and 318 iron meteorites given by Farrington, it is found that the weight percentage is 98.78 for the even and 1.22 for the odd-numbered elements, or the even-numbered elements are about 81 times more abundant.

If we consider these same meteorites, 443 in all, and representing all of the different classes, it is found that the first seven elements in order of abundance are iron, oxygen, silicon, magnesium, calcium, nickel and sulphur, and *not only do all of these elements have even atomic numbers, but in addition they make up 98.6 per cent. of the material of the meteorites.*

Table IV. gives the average composition of these meteorites. The numbers before the symbols are the atomic numbers, and

TABLE IV

Average Composition of Meteorites Arranged According to the Periodic System

Series	Group 1 Odd	Group 2 Even	Group 3 Odd	Group 4 Even	Group 5 Odd	Group 6 Even	Group 7 Odd	Group 8		
								Even	Odd	Even
2				6C 0.04%		8O 10 10%				
3	11Na 2 17%	12Mg 3.80%	13Al 0.39%	14Si 5.20%	15P 0.14%	16S 0.40%				
4	19K 0.04%	20Ca 0 46%		22Ti 0.01%		24Cr 0.09%	25Mn 0 03%	26Fe 72 06%	27Co 0.44%	28Ni 6.50%
	29Cu 0.01%									

those below give the percentages of the elements. *It will be noted that the even-numbered elements are in every case more abundant than the* ADJACENT *odd-numbered elements.* The helium group elements form no chemical compounds, and are all gases, so they could not be expected to remain in large quantities in meteorites. For this reason, and also because the data are not available, the helium or zero group is omitted from the table.

From this table it will be seen that while *high percentages,* as great as 72 per cent. in one case, *are common among the even-numbered elements,* the highest percentage for any odd-numbered element is less than one per cent. (0.39 for aluminium).

If we now turn to the composition of the earth, it is found that the atoms of even atomic number are about ten times more abundant in the surface of the earth than those which are odd. Also, all of the five unknown elements, eka-cæsium, eka-manganese 1, eka-manganese 2 (dwi-manganese), eka-iodine and eka-neodymium, have odd atomic numbers. It should be mentioned in this connection, however, that there is some doubt as to whether element 72 has been discovered.

While the relative abundance of the elements in the lithosphere is undoubtedly much affected by differentiation, there is one group whose members are so closely similar in chemical and physical properties, that they would be much less affected in this way than any other elements. These are the rare earths. The only difficulty in this connection is that of making an accurate estimate of the relative abundance. In this the writer has been assisted by Professors C. James and C. W. Balke, but any errors in the estimate should not be attributed to them. In the table, which includes beside the rare earths a number of elements adjacent to them, the letter *c* indicates common in comparison with the adjacent elements, and *r* represents rare. *ccc* represents a relatively very common element, etc. The comparison is only a very rough one, but it indicates that the even-numbered elements are in general more abundant than the odd-numbered ones which are adjacent.

TABLE V

The Predominance of Even-numbered Elements Among the Rare Earths

Atomic Number	Abundance	Element	Atomic Number	Abundance	Element
55	c	Caesium	63	rr	Europium
56	ccc	Barium	64	r	Gadolinium
57	c	Lanthanum	65	rrr	Terbium
58	cc	Cerium	66	r	Dysprosium
59	r	Prascodymium	67	rrr	Holmium
60	c	Neodymium	68	r	Erbium
61	rrr	Unknown	69	rr	Thulium
62	c	Samarium			

The above results may be summarized in the statement that IN THE FORMATION OF THE ELEMENTS MUCH MORE MATERIAL HAS GONE INTO THE ELEMENTS OF EVEN ATOMIC NUMBER THAN INTO THOSE WHICH ARE ODD, either because the odd-numbered elements are the less stable, or because some constituent essential to their formation was not sufficiently abundant, or as the result of both causes.

It is easy to see, too, that in the evolution of the elements, the elements of low atomic number and low atomic weight have been formed almost exclusively, and this indicates either that the lighter atoms are more stable than those which are heavier, or else that the lighter atoms were the first to get the material, and their stability was at least sufficient to hold it.

It is possible that the heavier atoms have been formed in larger amounts than now exist, and that their abundance has been reduced by atomic disintegration. It is of course evident that the radio-active elements are now disintegrating, but the radio-active series of elements includes only those of atomic number 81 (thallium) to 92 (uranium); and lead (82) is the end of the series as now recognized. For our purposes, however, we still call the atoms of atomic numbers 1 to 29 the lighter atoms, and from 30 to 92 the heavier atoms. The following table indicates that when defined in this way the lighter atoms are extremely more abundant. In the table the weight percentages are given, but it is evident that if these same figures were calculated to atomic percentages they would show even smaller values for the heavier elements. The table shows that although the heavy atoms have been so defined as to include more than twice as many elements as the light atoms, their total abundance is so small as to be relatively insignificant. The data are taken from estimates by Clarke and by Farrington.

TABLE VI

Illustrating the Large Proportion in Various Materials of the Elements of Low Atomic Numbers (1–29)

Material	Percentage of Elements with Atomic Numbers 1–29	30–92
Meteorites as a whole.	99 99	0 01
Stone meteorites	99.98	0.02
Iron meteorites	100.00	0.0
Igneous rocks	99.85	0.15
Shale	99.95	0.05
Sandstone	99 95	0 05
Lithosphere . . .	99.85	0 15

It is thus seen that SO FAR AS THE ABUNDANCE OF THE ELEMENTS IS CONCERNED, THE SYSTEM PLAYS OUT AT ABOUT ELEMENT 30, and it is of great interest to note that it is just at this point that other remarkable changes occur. For example, up to this point nearly all of the atomic weights on the oxygen basis are very close to whole numbers. On the other hand the elements with higher atomic numbers (28 to 92) have atomic weights which are no closer to whole numbers than if they were wholly accidental. Also, just at this point the atomic weights cease to be those predicted by the helium-hydrogen theory of structure presented in this paper (Table III.). This does not mean, however, that the helium-hydrogen system fails at this point, but that the deviations in the atomic weights for the elements of higher number are produced by some complicating factor. This would be most easily explained on the hypothesis that isotopes are abundant among the elements of atomic number higher than 28. Such a hypothesis should, of course, be confirmed experimentally before it is given much credence. It is quite possible, too, that radioactive disintegrations have proceeded downward in the system as far as iron, and that iron is the end of a disintegration series. If this were true, it would explain the great abundance of iron in the meteorites. In whatever way we may average the analyses of the materials found in meteorites or on earth, the two most striking elements from the standpoint of abundance are oxygen, the most abundant of the elements of very low atomic number (8), and iron, which has the highest atomic number (26) of any very abundant element.

The fact that the elements which have heavy atoms (atomic numbers 30 to 92, or more than two thirds of the elements) have been formed in such minute amounts would be very much more striking to us if we lived on an earth with a perfectly uniform composition. On such an earth, formed without any segregation, it is probable that almost none of these elements would have been discovered. Quite certainly such elements as gold, silver, iodine and arsenic would not be known, and copper, lead, zinc and tin, if known at all, would be in the form of extremely small specimens.

In this connection it may be remembered that the earth has the highest density of any of the planets. The data given in Table V. show that in the meteorites, which vary in density from about 2.5 for the lightest stone, to more than eight for the heaviest iron meteorites, the increase in density is not brought about by an increase in the abundance of what have been defined as the heavy atoms, but only by a shift in the relative abundance of the light atoms. Thus in the less dense stone meteorites the average atomic percentage of oxygen, atomic weight 16, is 54.7 per cent., while that of iron, atomic weight 55.84, is 10.6 per cent. In the more dense iron meteorites, on the other hand, the percentage of oxygen is practically negligible, while that of iron has risen to 90.6 per cent.[4] A study of the densities of the elements and their compounds shows that the abundance of the elements does not seem to be related to this property. In fact the only apparent relation is to the atomic number, which indicates that the abundance relations are the result of evolution, that is of the factors involved in the formation and disintegration of the atoms.

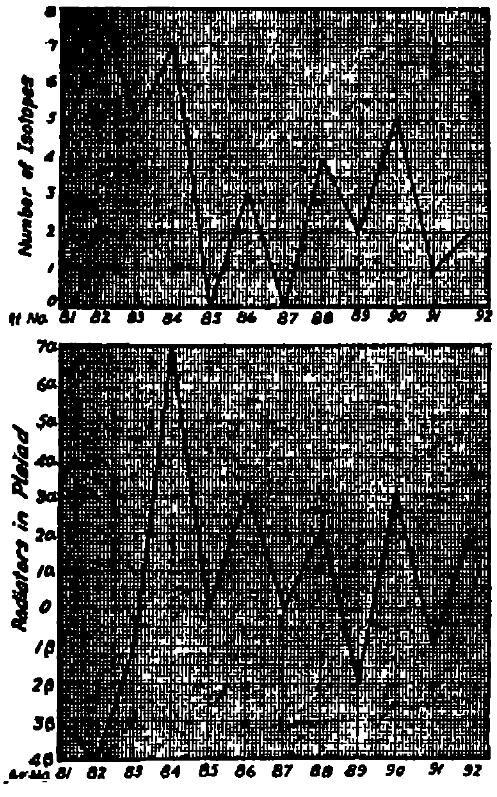

FIG. 4.

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UNIVERSITY OF CHICAGO

NOTE: Since the presentation of the above paper it has been pointed out by Norris F. Hall that both the *isotopic complexity*, and the *number of predominant radiation* of the radio-active elements show a sharp alternation with increasing atomic number, and that this alternation is strictly in accord with the general hydrogen helium theory of atomic structure. The variation of these properties is illustrated in Figure 4 and it will be seen that the general form of these figures is the same as that of Figures 2 and 3 which represent the abundance of the elements.

THE CARE OF WOUNDED SOLDIERS

MANY matters of importance touching upon American cooperative effort and activity along medical and surgical lines were developed during the past week in Chicago, when the general medical board and the State activities committee of the medical section of the Council of National Defense held stated meetings in conjunction with the annual meeting of the Clinical Congress of Surgeons of North America. Secretary of the Navy Daniels discussed the activities of the Navy directed toward the moral and intellectual welfare of the naval personnel, and Surgeon Generals Gorgas, Braisted, and Blue spoke for the Army, Navy, and Public Health Service, outlining the medical work in these respective branches.

Surgeon General Gorgas at a meeting of the general medical board, which preceded the clinical congress, outlined the efforts now being directed toward meeting medical needs on the fields of battle, at home, and also in transporting permanently disabled United States soldiers from abroad. Only those men will be returned home who are permanently disabled or who have a contemplated convalescence of six months. The experience of the allies, it was stated, indicates that about 10 per cent. of the wounded are permanently disabled.

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[4] For nickel, atomic weight 58.68, it is 8.5 per cent.

'On their return home the American soldiers will receive not only adequate medical treatment but will also be afforded the extra facilities of special hospitals built with the idea in view of rehabilitating physically and reeducating industrially our incapacitated soldiers. It is also contemplated to devote special hospitals in France to the treatment of special diseases, such, for example, as tuberculosis or injuries of the head, brain, eyes, ears, or face.

General Gorgas announced the fundamental policy of adhering to the Manual of 1914, which provides that the military hospitals shall consist of three general divisions, medicine, surgery, and laboratories. Under this type of organization the specialties will have full scope and yet come under adequate medical or surgical control and direction.

The Clinical Congress of Surgeons of North America is an organization founded seven years ago by Dr. Franklin H. Martin, of the advisory commission of the Council of National Defense, of Chicago. Surgical demonstrations were held at 25 important Chicago hospitals and programs were arranged almost exclusively along medico-military lines.

France was represented by Colonel C. Dercle and England by Colonel T. H. Goodwin, R. A. M. C. Sir Berkeley Moynihan presented the activities of the British Army and Major George W. Crile, M. R. C., detailed the American medical activities in France. '

After Colonels E. L. Munson and F. F. Russell had outlined the work of the Surgeon General's office in organizing the medical officers' training camps and the various military laboratories, Sir Berkeley Moynihan contributed an exposition of wound treatment in the British Army. He explained in detail the search for satisfactory antiseptic drugs and ventured the novel axiom that wounds did best when merely carefully cleaned, put at rest, and kept free from contact with any drug or antiseptic. His address attracted much attention because it was the first authoritative denial of the universal efficacy of the now famous Carrel-Dakin technique of wound treatment.

Major G. W. Crile, in discussing the address of Sir Berkeley, corroborated all that he said. Short addresses were made by Drs. Edward Martin, E. H. Dunham, and W. E. Lee, all of Philadelphia. By means of a moving-picture demonstration and the detailing of experimental and clinical data, they showed how much could be done for clean wound healing by the new antiseptic, Dichloramine-T, which is being investigated under instructions from the Surgeon General's office. Dr. William O'Neill Sherman, who presented evidence of the efficacy of the Dakin-Carrel method of wound treatment, closed the Tuesday evening program.

In addition to the usual committee reports, the meeting of the general medical board was livened by two instructive reports from Sir Berkeley and Major Crile. Sir Berkeley showed the remarkable efficiency developed by the Medical Corps of the British forces, and this despite the fact that 96 per cent. of the doctors were civilian physicians at the outbreak of the war. This efficiency is attributable, among other things, to the two important factors of "surgical teamwork" and surgical consultants. The principle of surgical teamwork was learned in the United States, said Sir Berkeley, and the principle of consultants (these consultants are picked from the leading surgical minds of Britain) was evolved from the necessity of having some one authoritative group to direct and correlate medical activities consecutively from the field dressing stations back to the base hospital.

Major Crile outlined this plan for the so-called clinical sector, which in brief is made up of a team of men, selected preferably from a university or hospital where they have previously worked in unison, and now distributed among the dressing, field, evacuation, and base hospitals of a given sector at the front. The object of such a unit is to secure at all times uniformity and continuity of oversight in the treatment of the wounded from the time of the first field dressing to the completion of convalescence.

At the meetings of the States activities committee resolutions were introduced and acted upon in regard to the universal training of young men above 19 for a period of six months, for the rehabilitation of rejected physically defective conscripts, and for the prophylaxis, control, and treatment of venereal disease.

DEATHS AMONG ORNITHOLOGISTS

The *Auk* publishes obituary notices of several ornithologists who have died recently from which we take the following facts:

Dr. Emil August Goeldi died suddenly at Bern, Switzerland, July 5, 1917, in the fifty-eighth year of his age. He was born at Ennetbühl, Canton of St. Gall, Switzerland, August 28, 1859. He studied at the Zoological Station at Naples and was assistant of Professor Ernst Haeckel at the Zoological Institute at Jena. In 1884 he went to Brazil and became associated with the museum in Rio de Janeiro. After the fall of the Emperor Dom Pedro II, in 1889, he retired from this position and lived for four years in the state of Rio de Janeiro. About 1894 he founded the museum in Para, now known as the Museu Goeldi. This institution which comprised not only a museum but also a zoological garden and a botanical garden was taken over by the state a few years later and Goeldi then became honorary director. In 1905, after twenty years of life in the tropics, he returned to Switzerland and took up his residence in Bern where, since 1908, he has been professor of zoology in the Cantonal University. He visited the United States in August, 1907, at the time of the meeting of the Seventh International Congress of Zoology in Boston. Dr. Goeldi has published a number of papers in English, German and Portuguese on various branches of zoology, but chiefly on mammals, birds and fishes.

Alfred John North died of heart failure at Sydney, Australia, May 6, 1917, only five months after the death of his former chief and associate, Dr. E. P. Ramsay. He was born in North Melbourne, Australia, June 11, 1855, and was educated in the public and grammar schools of Melbourne. Later he worked at the jeweler's trade for some years. At an early age he developed an interest in ornithology which was stimulated by visits to the National Museum at Melbourne and by the officers of this institution, Sir Frederick McCoy the director, and John Leadbeater in charge of ornithology. In 1878 he corresponded with Ramsay and eight years later went to Sidney to arrange the Ramsay collection of birds and the collection of eggs of the Australian Museum. After spending several months at this task he was asked to prepare the "Descriptive Catalogue of the Nests and Eggs of Birds found Breeding in Australia and Tasmania" which was published in 1889. About this time he was appointed an assistant to the curator, Dr. Ramsay, and in 1891 was made ornithologist of the museum, a position which he retained until his death. He has published many papers on the birds of Australia.

Rev. William Rogers Lord died in Dover, Mass., February 2, 1916, in the sixty-ninth year of his age. He was born in Boston, Mass., May 6, 1847. He graduated from Amherst College with the degree of A.B., in 1875 and from the Union Theological Seminary, in New York, in 1878, and had held pastorates in the East and in the West.

Mr. Lord was deeply interested in birds and especially in popularizing bird study and bird protection.

Dr. Bert Heald Bailey died at Cedar Rapids, Iowa, June 22, 1917. He was born at Farley, Iowa, May 2, 1875. Dr. Bailey graduated from Coe College in 1897 and received his master's degree from the same institution in 1900. In 1900 he also completed his course and received an M.D. degree from Rush Medical College, Chicago. In September, 1900, he became professor of zoology and curator of the Museum of Coe College, a position which he held at the time of his death.

He published a small volume entitled "200 Wild Birds of Iowa" in 1906, and was the author of numerous short papers and notes on mammals and birds which appeared from time to time in the *Proceedings* of the Iowa Acad-of Science and in *The Auk*. In addition, many valuable notes contributed by him appear in Anderson's "Birds of Iowa."

Francis Windle died at his home in West Chester, Pa., on February 24, 1917, in his seventy-second year. Mr. Windle was born in West Marlboro, Chester county, Pa. He lived most of his life in West Chester, having received his education in the schools of his native county and at the University of Michigan, at which latter place he took his law course. Owing to poor health Mr. Windle found it necessary to give up the practise of law and seek outdoor employment. He secured a position with one of the extensive nurseries at West Chester. Here his wide knowledge of botany acquired during his frequent outing trips, which constituted his chief recreation for years, proved a valuable asset. During his recreational activities his time was about equally divided between his study and observation of plants and birds, with the result that he became skilled in both botany and field ornithology.

For several years Mr. Windle taught biology at Darlington Seminary, West Chester, and also did some teaching at the State Normal School in the same place.

For about eleven years prior to his death he was connected with the Bureau of Zoology, Department of Agriculture of Pennsylvania, with headquarters at Harrisburg. He became assistant orchard inspector for the eastern end of Pennsylvania, and while acting in this capacity was made a member of the Chestnut Blight Commission, and later of the White Pine Blister Rust Commission. The duties of these positions took him all over the eastern end of the state and kept him out of doors where he could indulge his passion for botany and ornithology. He was a member of the Philadelphia Botanical Club and of the Delaware Valley Ornithological Club and kept constantly in touch with men in these fields.

SCIENTIFIC EVENTS

WAR SERVICE FOR CHEMISTS[1]

FRANCE and England freely acknowledge that they greatly decreased their efficiency by sending their scientific men to the trenches. Although they have since withdrawn most of those still alive and are now using them in special service, the dearth of technically trained men has been and is severely felt.

Secretary of War Baker, aware of this fact, is carrying out the full spirit of the *selective* draft, and specially trained men, so far as needed, are being assigned to the war service which they are trained to render.

More than others among scientific men, trained chemists have been needed for war purposes by both the Army and the Navy.

Fortunately, the American Chemical Society and the Bureau of Mines, acting cooperatively, foreseeing this need, took first a census of American chemists and later compiled from all data available a list of those enlisted. From this list of chemists actually in the Army and the Navy a large number have been selected for special fitness and have been already assigned. Many more, undoubtedly, will be so assigned, and if the present demand keeps up, it may later be necessary to ask for special enlistment for chemical work. That time has not yet arrived.

At present any chemist not required by law to enter chemical war service who enters voluntarily keeps one chemist in the ranks and deprives the chemical industries of his own service as well. A number of chemists have been commissioned, but these are picked men of special attainments and specific experience. The majority will serve as privates or non-commissioned officers until such time as they are found to deserve promotion.

Don't ask to be assigned to chemical work until you are actually in the camp. Camp assignment must be made before your name will be submitted to the War Department.

Don't send in your name, even for consideration for such service, if exemption is to be asked for or while exemption claims are pending. It leads to endless confusion.

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[1] From *The Journal of Industrial and Engineering Chemistry*.

Don't try to deprive another chemist actually in the Army of his opportunity to render chemical service by yourself seeking such service, *until called.* The industries which supply the Army and Navy with the sinews of war need trained chemists and are being seriously handicapped by the depletion of their chemical personnel.

Don't write to anyone in Washington to aid you in a claim for exemption. Even if they wished to do so, they are quite properly powerless for the law delegates exemption to the Local and District Boards

Do send me your name, address, military and camp assignment when actually sworn in (not before) If you have not already filed details of your age, training and experience, send this also at the same time.

Charles L. Parsons,
Secretary

American Chemical Society,
Box 505,
Washington, D. C.

THE MAYO FOUNDATION

At the meeting of the board of regents of the University of Minnesota held on September 13, the regents adopted the following resolution thanking the Drs. Mayo for their gift establishing the Mayo Foundation for medical investigation and research:

Whereas, Dr. William J. Mayo and Dr. Chas. H Mayo, of Rochester, Minnesota, have given the sum of $1,650,344.79 to the University of Minnesota for the establishment of a fund to be known as the "Mayo Foundation for Medical Education and Research," and,

Whereas, This gift has been duly accepted by unanimous action of the board of regents,

Therefore, be it Resolved, That the board of regents records its profound sense of gratitude to the donors. The gift is unique in the annals of American education. It represents the lofty purposes of two of the most distinguished citizens of our commonwealth They believe that this money has come from the people and that it should be returned to the people. It has been the sole aim of the donors to provide a fund which would be of permanent benefit to the state of Minnesota and to mankind as a whole. They have wisely and appropriately provided that the income of the fund shall be used for medical education and research. American universities should be encouraged in the prosecution of an educational policy which aims to develop investigators and scientists of the first rank. One clear function of a true university is to make actual contributions to various fields of knowledge. This new foundation, therefore, relates itself very intimately to the realization of our highest educational aims. Both for the gift itself and for the genuine impetus which it will impart to scholarly investigation in this university, we desire to convey to the donors our sincere appreciation.

THE CONNAUGHT LABORATORIES OF THE UNIVERSITY OF TORONTO

The Connaught Laboratories of the University of Toronto, and a farm of fifty acres, were formally presented by Colonel Albert Gooderham, to the University of Toronto and at the same time officially opened by the Governor General, the Duke of Devonshire, on October 25. The value of the gift is about seventy-five thousand dollars. The laboratories are to be used for the purpose of research in preventive medicine and for the production of serums and vaccines. Sir William Hearst, the premier of Ontario, at the opening, announced that a grant of seventy-five thousand dollars would be authorized at the next session of the legislature, to establish a research foundation in preventive medicine. The income from this and also from an additional twenty-five thousand dollars, will be used for research only, the laboratories being self-supporting. This is the first endowment of research in preventive medicine in Canada. In connection with the official opening of these laboratories, a lecture was delivered in Convocation Hall, on the same evening by Dr. Simon Flexner, director of the Rockefeller Institute for Medical Research, on the "War activities of the Rockefeller Institute." A distinguished audience, including the Governor General and the Lieutenant Governor, attended this most interesting and able lecture.

THE ANNUAL MEETING OF THE FEDERATION OF AMERICAN SOCIETIES FOR EXPERIMENTAL BIOLOGY

The annual meeting of the Federation of American Societies for Experimental Biology occurs this year at the University of Minnesota in Minneapolis. The scientific program covers the three days of December 27, 28 and 29. The Local Committee is planning attractive features of general interest, including a trip to Rochester, that center of medical and surgical activities which the war conditions have raised to a plane of paramount importance. The four societies of the federation are the American Physiological Society, the American Society of Biological Chemists, the American Society for Pharmacology and Experimental Therapeutics, and the American Society for Experimental Pathology. Many members of these societies are engaged in scientific work in support of our government in the great war struggle. The general secretary hopes that the scientific program will strongly reflect this present activity and that the meeting will be one of unusual interest and enthusiasm. The members of the societies are urged to make vigorous efforts to attend and to contribute to the program. The fact that the meetings of the American Association of Anatomists and the American Zoological Society occur at the same time and place lends the strong appeal of mutual and cooperative interest which every member of the federation will find it difficult to resist.

CHARLES W. GREENE,
General Secretary of the Federation.

COLUMBIA, MISSOURI,
October 25, 1917

THE PITTSBURGH MEETING OF THE AMERICAN SOCIETY OF NATURALISTS

THE American Society of Naturalists, in affiliation with Section F of the American Association for the Advancement of Science and the Botanical Society of America, will hold its thirty-fifth annual meeting at Pittsburgh, under the auspices of the University of Pittsburgh, beginning Tuesday, January 1, 1918.

There will be a smoker for Biologists on Saturday evening, December 29.

The Botanical Society of America will place the genetical papers of its program on Monday morning, December 31, and in the afternoon of the same day will present an invitation program including the presidential address of R. A. Harper.

Section F of the American Association for the Advancement of Science will have on Monday morning the address of the retiring vice-president, G. H. Parker, and in the afternoon a symposium on "The contributions of zoology to human welfare."

By this arrangement there will be sessions of interest to the members of the American Society of Naturalists on the day preceding the meetings of the society.

The American Society of Naturalists will offer for Tuesday morning, January 1, a program of invitation papers.

The program for Tuesday afternoon will be a symposium on "Factors of organic evolution."

The Naturalists' dinner, in which members of the affiliated societies are invited to participate, will be held on the evening of Tuesday. At the close of the dinner George H. Shull will give his presidential address, "The genotype and its environment."

As the result of an apparently growing desire on the part of members of the American Society of Naturalists to contribute papers, the Program Committee will this year receive titles for a program to begin on Wednesday morning, January 2. It is desired that the papers be short and it should be remembered that the interests of the Naturalists are primarily on problems of organic evolution. The papers on this program will in general be arranged in order of the receipt of the titles, except that papers on similar subjects may be grouped. Titles with estimated length of delivery and statement of lantern or chart requirements must be in the hands of the secretary by December 1.

Nominations for membership must be sent to the Secretary not later than December 1 in order that the Executive Committee may give them due consideration before the meeting. Blank forms for nominations may be obtained from the secretary.

Headquarters of the Naturalists will be at the Monongahela House, Smithfield and Water Streets. Members are advised to make early reservations.

Single rooms	$1.50; with bath, $2.00
Double rooms	$2.00; with bath, $3.00

Other hotels recommended by the local committee:

		Minimum rate for single room
Anderson	Penn and Federal	$1.50
Chatham	423 Penn Ave.	1.50
Colonial Annex	Sixth and Penn	1.00
Fort Pitt	Tenth and Penn	2 00
Henry	417 Fifth Ave.	2.00
Lamont	Spahr and Adler	1.00
Lorraine	Highland and Rodman	1 00
Motor Square	Center and Beatty	1.00
Newell	343 Fifth Ave.	1.50
Schenley	Bigelow Blvd. and 5th	2.00
Seventh Ave.	Seventh and Liberty	1.50
William Penn	Wm. Penn Place	2.50
Yoder	1112 Forbes St.	.50

Bradley M. Davis,
Secretary

University of Pennsylvania,
Philadelphia

SCIENTIFIC NOTES AND NEWS

Dr. L. I. Bailey was elected president of the American Pomological Society at the recent Boston meeting.

Dr. John Charles Hessler, professor of chemistry in the James Millikin University at Decatur, Illinois, has been elected to the presidency of the Illinois State Academy of Science.

At the Chicago meeting of the American College of Surgeons the following were elected fellows: Surgeon General Rupert Blue, United States Public Health Service; Surgeon General William C. Gorgas, United States Army; Surgeon General William C. Braisted, United States Navy; Colonel T. H. Goodwin, British Medical Corps; Colonel C. Dercle, French Medical Corps; Sir Berkeley Moynihan, Leeds, England.

Dr. Louis B. Wilson, of the Mayo Foundation of the University of Minnesota, has been appointed director of the foundation.

Frank C Baker, zoological investigator of the New York State College of Forestry, at Syracuse, formerly acting director of the Chicago Academy of Sciences, has been appointed curator of the university museum at the University of Illinois, where his work will begin within a couple of months.

A testimonial banquet was given by the Physicians' Club of Chicago, in honor of Dr. Frank Billings, at the Auditorium Hotel, on November 1. Dr. Augustus O'Neill acted as toastmaster. A silver loving cup was presented to Dr. Billings on behalf of the Physicians' Club.

A peerage of the United Kingdom has been conferred upon the Right Honorable Sir Francis Hopwood, vice-chairman of the Development Commission, and a member of the General Board and Executive Committee of the National Physical Laboratory.

President Poincaré has conferred the Legion of Honor upon Dr. John Cadman, C.M.G., professor of mining in the University of Birmingham, in recognition of valuable services rendered by him in the cause of the allies.

Professor I. Bandi has been placed in charge of the newly opened institution at Naples for the production of therapeutic serums and vaccines as a center for research in hygiene and biology, with special regard to colonial conditions.

P. F. Walker, dean of the engineering school and formerly head of the department of mechanical engineering at the University of Kansas, has been granted an indefinite leave of absence to enter the army. He has received a commission as Lieutenant Colonel and is stationed at Camp Cody, N. M. Professor George C. Shaad has temporarily assumed the duties of dean and Professor Frederick H. Sibley has been made head of the department of mechanical engineering.

James H. Bonner, professor of forestry in the Montana State University, has been appointed captain in the engineers' section of the officers' reserve corps.

Victor K. La Mer, formerly chemist at the Carnegie Institution, Cold Spring Harbor, Long Island, has received a commission of first lieutenant in the Sanitary Corps.

President William Jasper Kerr, of the Oregon Agricultural College, has been appointed head of the increased agricultural production campaign and chairman of the Food Committee of the State Council of Defense.

Professor H. S. Pratt, of Haverford College, assisted by Frank C. Baker, zoological investigator of the New York State College of Forestry, made during the past summer a study of the parasitic worms of Oneida Lake fishes. This work was made by cooperation between the U. S. Bureau of Fishes and the New York State College of Forestry at Syracuse, and was a part of the fish survey which has been carried on there for the past three years.

Professor Calvin H. Kauffman, curator of the Cryptogamic Herbarium, and professor in the department of botany of the University of Michigan, has left for Colorado where he will spend the year gathering and selecting mushrooms in order to experiment on them for certain malignant diseases which affect crops. Professor Kauffman was granted a year's leave of absence in order that he might work on these plant diseases for the United States government.

Dr. William C. Farabee, director of the University of Pennsylvania Museum, who recently returned from a two years' exploring trip to the Amazon River, is now engaged in installing the exhibits he collected. Thousands of rare specimens are being made ready and when finished they will occupy the entire floor of the museum. The collection, which will be opened to the public early in November, promises to be the finest of its kind in the world. In the absence of Director Gordon, Dr. Farabee is acting director of the museum.

Dr. Frank Carney, professor of geology and geography at Denison University, has resigned to enter the employment of The National Refining Company of Cleveland, Ohio.

L. M. Tolman, for seventeen years connected with the Bureau of Chemistry, U. S. Department of Agriculture, and for the last three years chief of the central food and drug inspection district of that bureau, has resigned to become chief chemist of Wilson & Co., Chicago, to have charge of their control and research work.

Sir Maurice Fitzmaurice, C.M.G., has been appointed to fill the vacancy on the advisory council of the Committee of the Privy Council for Scientific and Industrial Research of Great Britain, caused by the retirement, by rotation, of Mr. W. Duddell, C.B.E., F.R.S.

A Peruvian Medical Commission, which will tour the United States inspecting medical schools and hospitals, began its work in Baltimore, October 14, and from there went to Philadelphia and New York. The commission is composed of Professor Dr. Guillermo Gastaneta and Drs. E. Campodonico and R. Asplazu. The object of the commission is to secure information for the reorganization of the medical schools of Peru in accordance with American standards.

Dr. Henry C. Sherman, professor of food chemistry in Columbia University, who has recently returned from service in Petrograd as a member of the scientific division of the American Red Cross Mission to Russia, spoke of the work of the mission in Russia at Hastings-on-Hudson, New York.

Professor L. H. Bailey, of Cornell University, will present a paper on the evening of November 12 before the Society for the Promotion of Agricultural Science in Washington on "Permanent Agriculture and Democracy (suggested by the situation in China)."

Professor Simeon E. Baldwin, of Yale University, was reelected president of the Connecticut Academy of Arts and Sciences at its annual meeting on October 18. At this meeting Professor Baldwin read a paper on "The growth of law during the past year." Dr. Olive Day and Dr. George F. Eaton were elected vice presidents.

The Harvey Society lectures will be given at the New York Academy of Medicine, as follows: Nov. 10, Dr Carl L. Alsberg, Washington, D. C., "Current food problems"; Nov. 24, Dr. Linsly R. Williams, "The medical problem of the war"; Dec. 8, Professor Aldred S. Warthin, Ann Arbor, "The new pathology of syphilis."

Mr. Fisher, the British minister for education, presided, on October 31, at a meeting in London, which was addressed by Mr. Waldorf Astor, on "Health problems and a state ministry of health." Mr. Kingsley Wood, of the

London County Council, and others took part in the discussion.

Dr. George D. Hubbard, head of the department of geology of Oberlin College, will address the annual meeting of the Central Association of Teachers of Science and Mathematics at Columbus, Ohio, which will be held from November 30 to December 1, on "Why should geography be taught in the high schools?" Dr. Hubbard has recently been retained in Toledo in connection with certain problems of physiography and geography involved in the riparian case in litigation in which agricultural and fishing industries clashed.

Dr. R. H. Ward, of Troy, N. Y., known for his work in microscopy and from 1869 to 1892 professor of botany in the Renssellaer Polytechnic Institute, died on October 29, aged eighty years.

Sir William James Herschel, discoverer and developer of the system of identification by fingerprints, died on October 24. Sir William was born in 1833. He was the grandson of Sir William Herschel, the English astronomer, and the son of Sir John Frederick William Herschel, whom he succeeded in the baronetcy in 1871.

The death is announced of Mr. Charles Latham, at Glasgow. Mr. Latham was the first Dixon professor of mining in Glasgow University.

William Robert Sykes, the inventor of the lock-and-block system of railway signalling, died on October 2, at the age of seventy-seven years.

Under an agreement between the executors of the estate of the late James Buchanan Brady and his heirs, most of the estate, estimated at $3,000,000, is now available for the New York Hospital, and makes possible the establishment of the James Buchanan Brady Foundation of Urology, which is in accordance with the testator's plans. Dr. Oswald S. Lowsley, who was named by Mr. Brady as director, has the plans of the foundation in charge.

The Robert Dawson Evans Memorial for Clinical Research and Preventive Medicine of the Massachusetts Homeopathic Hospital will receive about $1,000,000, as residuary legatee of the estate of Maria Antoinette Evans.

The forty-fifth annual convention of the American Public Health Association opened in Washington on October 18. Herbert C. Hoover, director of the United States Food Administration, addressed the convention at its first general session. The program for the afternoon called for a joint session of the association with the American Social Hygiene Association, the Baltimore Medical Society and the Maryland Society for Social Hygiene. A symposium on easily preventable disease control in the army, the navy and the civilian community was given by Colonel F. F. Russell, U. S. A.; Surgeon R. C. Holcomb, U. S. N.; Raymond B. Fosdick, chairman of the commission on training camp activities; Assistant Surgeon General J. W. Kerr, of the Federal Public Health Service, and Surgeon William H. Frost, director of the Red Cross Sanitary Service.

The Civil Service Commission of the State of New York announces examinations for the State Department of Health for a physiological chemist at a salary of $1,500; for a laboratory assistant in chemistry at a salary of $720 to $1,200 and for a laboratory assistant in bacteriology at a salary of $720 to $1,200. These positions are open to non-residents and to citizens of other countries except those at war with the United States, and in the first two positions a degree from a college maintaining a standard satisfactory to the commission or an equivalent education is required.

UNIVERSITY AND EDUCATIONAL NEWS

Columbia University, New York University and the Presbyterian Hospital are beneficiaries in the will of Kate Collins Browne, who died on August 19. They will share the residue of the estate after half a million dollars is distributed in bequests.

YALE University has acquired by purchase another entire city block in the center of New Haven.

THE enrollment in the College of Medicine of the Universtiy of Cincinnati shows an increase of about 40 per cent. over last year. The enrollment in 1916 was 102 compared with 143 for the year 1917–18.

IN the Oregon Agricultural College Adolph Zeifle has been made dean of the newly created school of pharmacy; Miss Ava B. Milam dean of the school of home economics, and E. K. Soper, head of the department of mines at the University of Idaho, has been appointed dean of the school of mines to fill the vacancy made by the resignation of Dean H. M. Parks to head the Oregon Bureau of Mines and Geology.

PROFESSOR HOTCHKISS, of the department of business education of the University of Minnesota, has been made chief of the department of economics during the absence of Professor Durand.

PROFESSOR C. C. PALMER, of the College of Agriculture of the State University of Minnesota, has been appointed head of the department of bacteriology, physiology and hygiene, at the Delaware College, Newark, Del.

DR. ALBERT C. HERRE, for several years past professor of geography and agriculture in the Bellingham, Washington, State Normal School, has recently been appointed head of the department of biology in the same institution.

EBEN H. TOOLE, recently of the Kansas Agricultural College, Manhattan, Kansas, has been appointed to succeed Professor G. N. Hoffer as assistant professor of plant pathology and physiology, at Purdue University. Professor Hoffer has been transferred to the Agricultural Experiment Station of Purdue.

DR. C. C. FORSAITH, instructor in botany in Dartmouth College, has been appointed instructor in wood technology in the New York State College of Forestry.

E. A. REID, for the past two years instructor in electrical engineering at Minnesota, has resigned to accept a similar position at the University of Illinois.

PROFESSOR CLARENCE A. MORROW, formerly professor of chemistry in the Nebraska Wesleyan University, has been elected assistant professor of agricultural biochemistry in the University of Minnesota.

MRS. J. A. NYSWANDER has been appointed assistant professor of mathematics at the University of Nevada, to take the place of her husband, who has been called to government service.

DISCUSSION AND CORRESPONDENCE

THE "AGE AND AREA" HYPOTHESIS OF WILLIS

THE "Age and Area" hypothesis of Willis, recently discussed and endorsed by Professor De Vries in SCIENCE,[1] states that "the area occupied by any given species (of plants) at any given time in any given country in which there occur no well-marked barriers depends upon the age of that species in that country." The older the species is, in other words, the wider is its range. If confirmed, this hypothesis would be of the greatest scientific importance, for not only would it discredit the efficacy of natural selection—the point chiefly emphasized by its author and Professor De Vries—but, by enabling us to identify with certainty the most widespread types as the most ancient ones, in any given region or in the world as a whole, it would also clear up a host of vexed questions in plant geography and plant phylogeny. Certain objections to the hypothesis appear to be so great, however, as to cast doubt upon its universal applicability; and a careful study of the floras of Ceylon and New Zealand, the regions with which Professor Willis has chiefly worked, serves to emphasize the complexity of the whole problem involved.

Factors other than age evidently share in determining the area occupied by a species.

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[1] De Vries, H., "The distribution of endemic species in New Zealand," SCIENCE, N. S., Vol. XLV., No. 1173, pp. 641–642, June 22, 1917.

Barriers of various sorts certainly do exist almost everywhere and effectively limit the extent to which a species may be dispersed. We have reason to believe that many types are as widespread as they can ever be and that no increase in age, other factors remaining constant, will widen their ranges. In fact, evidence from fossils shows that certain species and genera occupy to-day smaller areas than they formerly did.

Factors inherent in the plant itself are also bound to influence the extent of its distribution. Types which are hardy and able to thrive under a wide range of conditions will obviously spread farther and faster that those which are sensitive or specialized. The growth habit of a plant, too, seems to be very important in determining distribution, trees usually occupying small ranges, shrubs wider ones and herbs the widest of all. This may be observed in almost any flora and is very noticeable in those of Ceylon and New Zealand, where the endemic species, necessarily of limited dispersal, are predominantly trees and shrubs; the non-endemic, widespread ones, predominantly herbs. The data as to relative commonness of species in Ceylon given in Trimen's "Flora," the authority used by Professor Willis, also show clearly that the herbs are much commoner and more widely dispersed than are the woody plants.

The theory that the most widespread types are the oldest meets with further difficulties from some of its implications. The fact which we have just mentioned, that species of herbs tend universally to have much wider ranges than those of shrubs or trees, a circumstance long ago noted and emphasized by De Candolle, must mean, if we follow Professor Willis, that the herbaceous element in the angiospermous vegetation of the globe is more ancient than the woody element. Against this conclusion there are serious objections, and it is at present maintained by few botanists or geologists. In its interpretation of endemic types the hypothesis is also open to objection, since it regards endemic species and genera in all cases as of recent origin, the newest element in their respective floras. There is much evidence, however, from taxonomy and paleobotany, that in many cases endemics are relicts of types once much more widely spread which have disappeared from all regions save one. Such endemics are evidently ancient rather than recently acquired members of a flora.

This point involves the necessary corollary to his hypothesis which Professor Willis brings forward when he states[3] that the "dying out" of a species is a rather rare event, usually requiring some profound geological or climatic change. This belief in the essential permanency of types necessarily leads Professor Willis to the view that species or genera which are isolated taxonomically and without near relatives have become so not through the extinction of intermediate and connecting forms, but by a single step, a view demanding belief in the frequency and permanence of wide mutations. If we look again at the fossil record, however, we see such an overwhelming array of extinct types that it is hard to attribute their extermination in every case to a cataclysmic disturbance. This difficulty increases when we examine the flora of any such isolated region as Ceylon or New Zealand. If Professor Willis's hypothesis is correct, the original invaders of each of these islands—its oldest plant inhabitants—should now be the most widespread and common members of its flora, in contrast to the endemic forms which have sprung from them and are thus more rare and local. If we look at the flora of Ceylon, however, we find that there are no less than 63 genera of dicotyledons alone, 8 per cent. of the whole, which, though not endemic in Ceylon, are represented only by *endemic* species. In New Zealand 90 non-endemic genera of dicotyledons, or 43 per cent. of the whole, are similarly represented only by endemic species. In these cases, where in each genus is the parent species or group of species, the original invader, which has supposedly given rise to all these endemic forms and which should now be more common than any of them? It certainly has died out in some way, since it no longer exists in the island.

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[3] Willis, J. C., "The evolution of species in Ceylon, with reference to the dying out of species," *Annals of Botany*, Vol. XXX., 1916, p. 1.

A further objection to the hypothesis lies in its particular application to the flora of New Zealand. On the basis of the soundings, Professor Willis believes that the land bridge over which came the original plant population of the islands entered at about the center of the chain. He presumably refers to the strip of shoal water running northwesterly from New Zealand toward Australia, on which stands Lord Howe Island. On the assumption that all the original invaders entered at this central point and spread north and south, and that in doing so they followed the rule of "age and area," Professor Willis makes and verifies a series of predictions as to the disposition of the flora to-day. His whole argument hinges on the existence of an original central point of entry and dispersal. It neglects entirely the evidence that a large and characteristic element of the New Zealand flora entered the islands *not* from Australasia on the west, but from the antarctic regions to the south. Hooker, Wallace and Cheeseman, the foremost authorities on antarctic floras, state their belief that, even if there was never a complete land bridge from the southern extremity of New Zealand to the antarctic continent, there was at least a considerable southward extension of New Zealand at one time (for which there is also evidence on the ocean bottom) over which the "antarctic types" came north and entered it. If the southern tip of New Zealand was thus also a center of entrance and dispersal for a large floral element, Professor Willis's observations are far from supporting his hypothesis. He notes particularly the scarcity of endemic species at both the north and south extremities of the islands, and points to this fact as convincing confirmation of his views, since (assuming a single central point of dispersal) the extremities would be populated last and would have produced as yet but few endemics. But assuming a second point of entry, at the southern extremity of the islands, we should expect to find there to-day, if the "age and area" hypothesis is true, a decided bunching of endemic species. Either the hypothesis is incorrect, or the commonly accepted theory as to the dispersal of the antarctic floras is erroneous.

Against Professor Willis's hypothesis are therefore to be urged (1) that it disregards important factors other than age which determine area of dispersal; (2) that the conclusions which it necessarily implies as to the antiquity of certain plant types are opposed by a preponderance of evidence; (3) that, contrary to its expressed assumption, many species are becoming rarer and are "dying out"; and (4) that it fails to explain the distribution of the New Zealand flora.

There are doubtless a large number of species which are still extending their ranges and for which Professor Willis's hypothesis holds good. Many persons will also sympathize with his chief contention, that natural selection can not fully explain the origin of endemic species and genera; and a few will share his belief in the frequency and importance of very wide mutations. The problems involved in the origin, dispersal and extinction of species, however, are evidently far too complex to be covered by any single inclusive hypothesis like that of "age and area."

E. W. SINNOTT

CONNECTICUT AGRICULTURAL COLLEGE

ERASMUS DARWIN AND BENJAMIN FRANKLIN

TO THE EDITOR OF SCIENCE: Referring to the Notes on Erasmus Darwin and Benjamin Franklin in SCIENCE of September 21, last, on page 291 near the bottom of Column 1 is the remark that

> Even as far back as 1772 some one was puzzling over the idea of making a phonograph.

He quotes Dr. Darwin as saying:

> I have heard of somebody that attempted to make a speaking machine, pray was there any truth in such reports?

The "speaking machine" referred to was not a phonograph for reproducing speech, but a machine which could talk of itself. There was an effort to make such a machine, which the writer of the article quoted seems not to have heard of. This effort was continued down to the time of the invention of the phonograph, and somewhat beyond that time. One Joseph Faber began to work on an idea of this sort in 1815, and in 1841 had the machine so far finished that it was exhibited to the king of Bavaria, as stated in an article from the *London Times* of February 12, 1880, which is now lying before me. This machine was exhibited in America in the seventies and eighties and I heard it talk and ask and answer questions put by the audience. Its speech was very mechanical, without inflection or emphasis. It was worked by an attendant with a keyboard and bellows. An ivory reed whose pitch could be varied formed the vocal chords. The cavity of the mouth could be changed in shape and size by the keys of the keyboard. A tongue and lips of rubber formed the consonants. A windmill in the throat rolled the R's and a tube was attached to the nose when it spoke French! It could also speak German and English. It is not probable that any one had thought of a phonograph in the sense in which we use the term as early as 1772. Knowledge of electricity was not sufficiently advanced at that time.

W. C. PECKHAM

QUOTATIONS

THE PHYSIQUE OF RECRUITS

IN the summer of 1916 the Board of Scientific Studies was established under the ægis of the Royal Society to serve as a means of placing knowledge in the possession of scientific and technical societies at the disposal of government departments. At the first general meeting of this board in July, 1916, the urgency of a physical survey of the nation, to discover whether or not there existed definite evidence of physical deterioration, was discussed. Emphasis was laid by various speakers on the fact that an Interdepartmental Committee had reported in 1904 that such a survey was necessary. Nothing, however, had been done. The mobilization of a national army had provided an opportunity, as well as a need, for such a survey.

The Board of Scientific Studies requested the Royal Anthropological Institute to report on the desirability and possibility of such a survey. The institute having reported that such a survey was both desirable and possible, the board formed an Anthropological Survey Sub-committee to consider the manner in which such an investigation could best be carried out. This sub-committee has not yet reported to the Board of Scientific Studies, but we understand that it is seeking for the means of carrying out such a survey through the government departments which have directly to do with the health and physique of the nation: the Recruiting Authority—now the Ministry of National Service—the Local Government Board and the Board of Education. Representatives of these departments have joined the Anthropological Survey Sub-committee, and it is hoped that a practical scheme may be formulated at an early date.

Meanwhile American anthropologists have stolen a march on their British colleagues. When the United States entered the war the National Research Council was at once created to serve the same purpose as our Board of Scientific Studies. Its Anthropological Committee, formed to advise in the selection, standardization and examination of recruits, has already issued its report and recommendations. It proposes that six of the sixteen great concentration camps should be selected for an anthropological survey—two in the Eastern, two in the Middle, and two in the Western States—and that special men who had been trained to use exactly the same anthropometrical methods at the National Museum at Washington, should be dispatched to carry out a survey of the men in the selected camps. The points for investigation have been reduced to a minimum, namely, standing and sitting heights, three dimensions of the head, two of the face, two of the chest, with precise records of the color of skin, eyes and hair. The statistical staff of the Prudential Insurance Company of America has undertaken to deal with the data collected, while the Smithsonian Institution will facilitate the publication of results.

Although the intentions of the British committee are more wide-reaching and aim at ascertaining the condition of all elements in the population, it is to be hoped that the observations taken in Britain and America will be capable of direct comparison—for, beyond doubt, the bulk of the population of the United States has a British ancestry.

SCIENTIFIC BOOKS

Mental Conflicts and Misconduct. By WILLIAM HEALY. Boston, Little, Brown & Company, 1917. Pp 330.

Like earlier studies from the psychopathic institute attached to the Chicago Juvenile Court, this work emphasizes the need of painstaking inquiry into the experience and inner life of the individual delinquent, if the treatment given him is to be in any sense remedial. The present book illustrates the author's method of "mental analysis," a process somewhat akin to the "psychoanalysis" of Freud, though not making the same pretensions to penetrate to the very depths of the individual's make-up, and not operating with dreams, symbols or association tests, but by a straightforward conversational approach, in which the subject is sympathetically asked to tell "if anything is worrying him." This line of approach is especially indicated when the subject shows signs of an "inner urge" towards misdoing, without deriving any material benefit, but only painful consequences, from his misdoing. In such cases, there is reason to suspect a "mental conflict," which may be discovered by the analysis and then cleared up by proper handling, with the happy result that the misconduct ceases.

The mental conflict discovered by analysis is often of the following stamp. A young child, previously a good child, and often of good intelligence and from a good home, is incited by some bad boy or girl or older person to sex practices, and very often at the same time to stealing or truancy. The child rejects the sex practices, though often obsessed by the thought of them or by the bad words used in connection with them, but begins to steal or run away from home. The author interprets this to mean that an "inner urge," primarily directed towards sex behavior but prevented from finding an outlet there, escapes through the channel of stealing, etc., which has become accidentally associated in the child's mind with the sex matter. From such causes, quite a career of delinquency may be entered upon by children who are fundamentally normal and healthy-minded.

As judged from a series of two thousand juvenile recidivists, the per cent. of cases of delinquency in which mental conflict of this general type enters as a causative factor is about seven—more rather than less. It is not the "rough" type of juvenile offender that is here in question, nor the mentally defective. Usually the cases show good mentality and good social qualities. They are not moody and "shut-in," nor egocentric, nor, indeed, of any peculiar mental or temperamental type (unless, as is possible from the tests given, the imagery or mental representation of these individuals is unusually active and vivid). Heredity does not appear as an important factor; but it is rather the social or mental environment of the child that generates the conflict Specially important in this regard is the lack of confidential relations between the child and his parents, leading the child to keep his difficulties to himself, when a frank discussion of them with a sympathetic adult would resolve the conflict.

The treatment appropriate to this species of delinquents is by no means punishment—an entirely superficial and notably unsuccessful reaction—but, first of all, mental analysis directed to discovering the genesis of the misconduct, and then "reeducation," including the giving of suitable information and the development of an intelligent attitude towards the causes of conflict; further, the establishment of confidential relations between the delinquent child and an adult adviser, and often the removal of features of the environment that suggest misconduct.

Psychologically, the author's case-material is of great interest, and the interpretation given, in terms of mental conflict, is likewise of considerable interest, though it does not appear to fit all the cases equally well. To the reviewer, at least, a rather different "mental mechanism" would seem to fit the case histories better. In particular, the association between sex behavior and such other forms of misconduct as stealing and truancy is perhaps not so purely accidental and extraneous as the author assumes; for all of these forms of bad conduct typify for the child that life of "badness" which, perhaps because of its rebellion against authority and restraint, makes a certain appeal even to the "good" child. That is to say that the child does not resort to stealing as an outlet for dammed-up energy primarily directed towards sex behavior, but that, being incited to "badness" in several directions, and responding in some measure to the incitation, he follows the line that he is able to understand and follow with some success, leaving aside what he is not ripe for, though perhaps being mystified and obsessed by this latter.

R. S. WOODWORTH

COLUMBIA UNIVERSITY

Telephone Apparatus. By GEORGE D. SHEPARDSON, Professor of Electrical Engineering, University of Minnesota. D. Appleton & Co. 1917. 337 pages, 115 illustrations.

Considering the marvelous rapidity of growth of telephony and the extent to which the telephone permeates the daily life of the modern business man, especially in America, where there is an average of one telephone to each ten persons, it is surprising how little is generally known concerning the history, construction or mode of operation of that wonderful device. This book presents an introduction to the development and theory of telephony for the educated classes of the public in general, and particularly for those engaged in telephonic operation or manufacture.

The book contains sixteen chapters, relating respectively to the following subjects: Introduction, Sound, Speech sounds, Telephone receivers, Telephone-receiver investigations, Telephone transmitters, Telephone-transmitter investigations, Signaling devices, Design of non-polarized signaling apparatus, Permanent magnets and polarized apparatus, Design of polarized apparatus, Electromotive forces and currents, Principles of induction coils, Uses of induction coils in telephony, Condensers in telephony, Protective devices. The treatment is directly descriptive, abundantly illustrated by pictures and diagrams of the apparatus. The mathematical analysis is nearly all collected into the appendices at the end of the book, so that a non-mathematical reader can peruse all the chapters with very few interruptions.

The book deals mainly with telephonic apparatus, and the principles underlying its operation. Circuit arrangements are given relatively minor consideration, and radio-telephony is not included. A good set of indexes at the end of the volume greatly assists the reader.

A noteworthy feature of the book is the large number of collateral references indicated in footnotes throughout the text. The collection and collation of so much historical and technical material represents a large amount of labor. The insertion of this subordinate material makes the work of great value as a reference book to telephonists and students of telephony. Probably no other text-book on telephony in the English language contains such a wealth of electro-technical reference material.

A. E. K.

SPECIAL ARTICLES

ANESTHESIA AND RESPIRATION[1]

THERE is much uncertainty as to the effect of anesthetics upon respiration. Some writers hold that anesthetics decrease respiration while others take the opposite view.[2] To clear up this confusion appears to be a necessary step toward a satisfactory theory of anesthesia.

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[1] Preliminary communication.

[2] *Cf.* Höber, R., "Physik. Chem. der Zelle und der Gewebe," Ch. 8 und 9, 1914. Czapek, F., *Biochem. der Pflanzen*, Vol. I., S. 195 ff., 1913. Ewart, A. J., *Annals of Bot.*, 12: 415, 1898. Tashiro, S. and Adams, H. S., *Amer. Jour. of Physiol.*, 33 xxxviii, 1914. Appleman, C. O., *Amer. Jour. of Bot.*, Vol. 3, No. 5, May, 1916.

The writer has recently been able to develop a method[3] for the measurement of minute amounts of carbon dioxide. The application of this method to the present problem has yielded interesting results.

The experiments were made by measuring the change in the hydrogen-ion concentration of sea-water produced by the respiration of the marine alga, *Laminaria*. This was conveniently done by the addition of a suitable indicator (phenosulphonephthalein) to the sea-water and comparing the color of the solution with the colors of a series of buffer solutions of known hydrogen-ion concentration (containing the same concentration of indicator).

When the concentration of the anesthetic was so great as to cause considerable dilution of the sea water, concentrated sea water was added until the mixture had the same electrical conductivity as sea-water. When an anesthetic (as formaldehyde) showed an unusually high acidity, the free acid was first neutralized with sodium carbonate. This is allowable for the purposes of the present investigation, as its only effect would be to make the amount of CO_2 produced appear somewhat less than was actually the case. By selection of sea-water from different carboys, sea-water could be obtained for controls that had the same PH value as that of the sea-water containing the anesthetic.

The fronds were cut up into pieces about two inches long, the cutting being reduced to a minimum, since it is known that an increase of respiration may follow injury.[4] Preliminary experiments, in which uncut smaller fronds were used for comparison with the cut fronds, showed that the change in the respiration due to the cutting was negligible (especially since the cut pieces were usually left about half an hour in sea-water before being used).

Each piece of tissue was inserted into a Pyrex glass tube, closed by fusion at one end, a piece of paraffined rubber tubing being attached to the open end. Sea-water was then added, the solutions being the same temperature as the bath. The temperature of the bath was always kept at 16° C. Black-enamelled collapsible tin tubes served to exclude light from the tubes. After the sea-water bathing the tissue had been changed several times, a given amount of sea-water was added to the tube and a small bubble of air was included in order to serve as a stirrer (it was found to be preferable to paraffined glass beads). After the tube had been kept in the dark at 16° C. for a definite period it was removed from the bath and stirred by inverting the tube a few times. The clamp was then opened and the solution rapidly poured into an empty tube, to which the same number of drops of indicator had been added as was added to the buffer solutions. The solution was then mixed with the indicator in the manner just described and the color was then compared with buffer solutions of a known PH value (containing the same concentration of indicator). The decrease in PH as observed with a constant source of light ("Daylight" lamp) served to measure the amount of CO_2 produced by respiration.

In order to be sure that no acid except CO_2 was being given off by the plant a stream of hydrogen was allowed to bubble through the solution which had been made acid by respiration in order to see whether it came back to the same PH value as at the start.[5] This was the case in every instance

Each piece of material was used for a number of periods (always of the same length) in sea-water (which was changed at the end of each period) until the rate of respiration had become practically constant. Then several of the pieces were used as controls while others were placed in sea-water containing the anesthetic (the solutions were always renewed at the end of each period).

Experiments were carried on with sea-water containing the following substances: .1 per cent. chloral hydrate, .1 per cent. novocain, 1 per cent. ether, 0.1 per cent. caffeine, ethyl bromide (approximately saturated), 3.2 per cent. formaldehyde, .8 per cent. formaldehyde, .3 per cent. chloroform, .05 per cent. chloroform, 0.1 per cent. acetone, 0.51 per cent. acetone, 17.4 per cent. acetone, 24.2 per cent. ethyl alchohol, 16.1 per cent. ethyl alcohol, 10 per cent. ethyl alcohol, 5 per cent. ethyl alcohol, 2 per cent. ethyl alcohol and 1 per cent. ethyl alcohol.

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[3] Haas, A. R., SCIENCE, N. S., 44: 105, 1916.

[4] *Cf.* Richards, H. M., *Annals of Bot.*, 10: 531, 1896; *ibid.*, 11: 29, 1897.

[5] In very strong concentrations (alcohol 24 per cent. or acetone 17 per cent.) a little pigment may be extracted from the plant. In this case it may be necessary to reject the figures for the first period (or of the first two periods).

It was found that whenever the concentration of anesthetic is sufficiently strong to produce any measurable result, the initial effect is always an increase of respiration which may either remain approximately constant over a large number of periods and then gradually decline or the increased rate of respiration may fall very rapidly below the normal when the concentrations of anesthetic are too great.

It is very noteworthy that in no case was the respiration of *Laminaria* observed to fall below the normal when exposed to sea-water containing anesthetic except after prolonged exposure to high concentrations which produced death.

SUMMARY

When *Laminaria* is exposed to the action of anesthetics (in sufficient concentration to produce any result) there is an increase in respiration. This may be followed by a decrease if the reagent is sufficiently toxic. No decrease is observed with low concentrations which are not toxic.

These facts contradict the theory of Verworn that anesthesia is a kind of asphyxia, for his view is based upon the assumption that anesthetics decrease respiration.

A. R. C. Haas
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AN OUTLINE OF THE LIFE HISTORY OF THE CLOTHES MOTH, TINEOLA BISELLIELLA

Some four years ago the writer was asked by Mr. Walter S. Kupper and Mr. J. R. Howlett, of New York City, to undertake an investigation of clothes moths for the purpose of gathering information which would help solve the problem of moth-proofing ordinary woolen fabrics. At that time and at present, the only original information available consisted of disconnected observations, mainly concerned with the case-forming clothes moth, *Tinea*. In connection with the study which followed, hundreds of pounds of fur and old woolen rags were purchased, the moth larvæ painstakingly picked out, and the rags then sold back or thrown away. One lot of eighteen hundred pounds of old rags was purchased at one time. From these several thousand larvæ of *Tineola* was picked out by boys employed for that purpose, and placed on test cloths which had been treated with various chemicals in the hope of finding one which would prevent moth ravages. Two trunksful of fur garments were obtained from the Salvation Army stores. Two hundred pounds of blown fur were purchased from a firm which prepares rabbit fur for the hatter's trade.

The yellow clothes moth, *Tineola bisellliella*, was the only moth found in all this material during a period of four years. This seems strange, especially in view of the fact that the rag material had been shipped to New York from all parts of the country, the large bale of cloth above mentioned having come from the south and consisting of dirty cast-off clothing from that region. About three specimens of the spotted clothes moth, *Tinea*, were caught flying about the house in the Bronx, New York City, in which the study was at first carried on, but the circumstances indicated that they were adventitious, and in no way connected with the supply of *Tineola* fur of which only a few cardboard boxes were present at that time. The conclusion would seem inevitable that in the region of New York City, at least, *Tinea* is of comparatively rare occurrence and that the extensive damage which is done in connection with the fur and woolen trades is due almost entirely to the other species. Both the black and the Buffalo carpet beetles were found invariably in each supply of moth material, but in comparatively small numbers. A much larger unidentified beetle occurred in great numbers in the supply of blown hat fur and rabbit skins which had their source in Australia.

Life History.—Mature moths were found

emerging from cocoons in the fur material first studied in June and July, 1913. These were caught and placed in pairs for breeding purposes in jelly tumblers which were easily covered. The females were almost invariably larger than the males and much less active. Breeding began usually immediately after emergence from the cocoons. The males were active in pursuit, fluttering and running about the female and bringing the flexible abdomen forward until it pointed anteriorly. During copulation the moths rested with bodies in opposed directions. The abdomen of the female was always large and distended with eggs even before copulation.

Egg-laying began within twenty-four hours after breeding. Single females were found to lay from thirty to one hundred and sixty eggs, but the latter number was very exceptional and by only one unusually large moth. The usual number was between forty and fifty. The egg-laying might be completed in one day or it might continue two or three weeks. The female died when the eggs were all laid. The males might live and continue active and breeding for two or three weeks. Twenty-three days was the longest period observed. The eggs were carefully placed among the threads of the cloths and fastened by some glutinous material so that they did not readily shake off. If the cloth had a ravelled edge, the female would generally place most of the eggs deep among the loose threads.

To receive the eggs, small pieces of woolen cloth were generally used. When cotton cloth was tried experimentally, the moths did not differentiate, but laid on cotton stocking material and also on silk.

For incubation and brooding, Petri dishes were used and the egg-covered cloths were placed one in each dish. Hatching began in seven days, the larvæ emerging as millimeter-long translucent-white active caterpillars. These began to feed immediately and were then colored according to the color of the cloth used. Experiments were tried with felts of several colors and as a result larvæ could be obtained with a median streak of red, blue, green, *et al.* The dyes passed through the alimentary canal apparently unchanged, and it was always possible to determine by the excreta what material had been fed upon when there were cloths of different colors.

The larvæ behaved differently in the matter of case making. Some began immediately to spin a webbing case or sometimes a passage several times the length of the body in which they would live for a longer or shorter length of time. Woven into this "silk" tunnel were usually fibers from the material from which they were feeding. In the case of fur, the resulting case would often have the appearance of a bur with the hairs woven crossways and forming a case sometimes much thicker than long. On cloth, the case was made of shorter fibers closely attached to the cloth, thus distinguishing it from the cases formed by *Tinea* which are carried about. When a *Tineola* larva wished to change its feeding place it would either continue its gallery, sometimes for several inches, or would leave it entirely and build another when a satisfactory place was reached. As the larvæ grew to mature size, the feeding case was enlarged and changed to form the cocoon.

Other larvæ seemed to spend their time "grazing" about without ever forming more than small patches of silk if any. No conclusion was drawn as to the probable explanation of the difference. It might be that the quieter kind were eventually to form the female moths, and necessarily had less energy to spend in roaming. If this is true, it establishes another instance of the application of Kipling's law, for the larvæ which remained in cases do much more damage than the roaming kind. Moth holes usually appear as round holes, or as dumbbell-shaped slits The latter are made by the feeding of a stationary larva, the straight slit part being cut out underneath the case, the enlarged ends being at either opening of the case. The single holes are merely the feeding places at the ends of a case without the connecting split. These stationary larvæ also use much more cloth in order to make their cases. Of course both types enter cases at the end before passing into the pupa stage.

The larval stage may be completed in about ten weeks. It was found difficult to carry definite specific larvæ under observation in Petri dishes through the entire period, but the time was established by noting the appearance of new groups of moths in the larger stock of fur. Just what there was in the Petri-dish method of culture to hinder the larval development could not be determined. Some larvæ grew to large size, approximating maturity, others died in a few weeks, but none were certainly carried from the egg to the cocoon. Ten weeks appeared to be the shortest period in which larval growth was completed, but this is necessarily partly an estimate.

The cocoon stage lasted at the shortest two weeks. This was definitely established by observing the time at which larvæ ceased feeding, and closed their cases, and then putting such cases away for observation.

It is probable that all stages of the life history may under some circumstances be more or less indefinitely lengthened. Certainly the larval stage may. Its conclusion probably depends entirely on the obtaining of a sufficient amount of food, and may probably last several months, as over winter for example. Winter stops the activities of this moth only when the temperature of the surroundings is too much lowered. In the present investigation moths were observed emerging from cocoons and larvæ were seen feeding during all months of the year. Breeding experiments were not attempted during the winter but there seems no reason to suppose they would not have been successful and that egg-laying would also have occurred.

Remedies for Moths.—A summary of results along this line may be interesting.

Remedies intended for the flying-moth stage are worse than useless. So-called repellants such as tobacco, cedar, did not repel or harm the moth in any stage. The imago stage is the most delicate of all, but it could be placed in a small closed tumbler with burning tobacco with no apparent injury. Cloth soaked in odoriferous substances for the purpose of repelling them was made the recipient of eggs as readily as untreated cloth. As already noted, the moth laid eggs as readily on cotton and silk as on wool although neither of these was used as food by the larvæ.

Any method of attack must be directed toward the larval stage to be effective. Camphor and napthalene in closed places kill all stages. The egg and larvæ turn from whitish to a yellowish brown in color; the larvæ cease activity almost immediately. No gaseous poisons were tried but undoubtedly the common ones would be effective. Kerosene and gasoline fumes were not effective.

The main method of attack in this case was directed toward poisoning the larvæ through their food. The problem was to find some poison which could be placed on cloth and serve to kill larvæ feeding on it before they could do material damage. At the same time it must not be harmful to human beings, or if harmful in posse, must be insoluble. If baby wants to chew mother's dress or its woolen blanket, it must be able to do so with impunity. After about four years of nearly continuous investigation, during which several chemists were cooperating, the problem was finally dropped. Numerous compounds were used in tests but the larvæ proved singularly immune. Larvæ placed in Petri dishes with a piece of cloth soaked in corrosive sublimate as well as other common poisons, ate of the cloth as shown by the color of their alimentary canal and the fæces, but lived on for weeks apparently uninjured. Some few substances were found which did appear to have some result but not enough to justify adopting them as the basis of a moth-proofing process.

The problem still seems to be possible, but the solution is not apparent. After the substance is found, there still remains the overcoming of the objections of the tailors and clothing manufacturers, some of whom consider clothes moths among their best friends.

Ralph C. Benedict

Brooklyn

A CHROMOSOME DIFFERENCE CORRELATED WITH SEX DIFFERENCES IN SPHÆROCARPOS

The chromosome group found in the cells of the female gametophyte of *Sphærocarpos Donnellii* contains one large element which considerably exceeds both in length and in thickness any of the older chromosomes. The chromosome group of the male gametophyte contains no element similarly distinguished by its size; on the other hand, the male possesses a very small chromosome which seems not to correspond in size to any element in the female.

The other chromosomes in the cells of either sex have the form of slender rods; there are noticeable differences in length between those of each group. The bending and not infrequent overlapping of the ends of the chromosomes place difficulties in the way of an exact determination of their number; but, subject to modification by further study, it may be said with reasonable assurance that the chromosome number for each sex is eight. As to seven of the eight, the chromosomes of the male seem to resemble those of the female; but the eighth chromosome of the female is probably corresponding to it in the male is the the large one already referred to, and the one very small chromosome.

Of the two spindles formed in each spore mother cell at the time of the homœotypic division, one shows a large body which is sometimes plainly two-parted; no element appears on the other spindle that approximates in size this large chromosome. It has been reported that in at least one species of *Sphærocarpos* two of the spores of each tetrad develop into male plants and the other two into females. Observations which I have made, although as yet in limited number, indicate that the same rule holds for *S. Donnellii*. The cytological results here reported seem to show that in consequence of the chromosome distribution in the reduction divisions two of the four spores derived from a single mother cell receive each a large chromosome (and seven of smaller size), and these spores develop into female plants; and that each of the other two spores receives a small chromosome instead of the large one, and, on germination, gives rise to a male plant.

The resemblance between this history and that of the chromosomes of certain insects, such as *Lygæus* and *Euschistus*, which possess a large X- and a small Y-chromosome, is obvious. It is too early to conclude that the particular chromosomes with respect to which the male and female gametophytes of *Sphærocarpos* differ are the bearers of definite sex-determining factors; but it seems not unlikely at least that the greater size and vigor of growth of the female gametophyte are associated with the greater amount of chromatin that its cells contain.

Charles E. Allen

University of Wisconsin

THE AMERICAN ASTRONOMICAL SOCIETY

The twenty-first meeting of the society was held August 29 to 31 at the Dudley Observatory, Albany, N. Y., about ninety members and visitors being present. The arrangements for the meeting were admirably carried out by the host, Professor Benjamin Boss, acting also for the trustees of the Dudley Observatory and the department of meridian astrometry of the Carnegie Institution of Washington. The activities included an excursion to Saratoga Lake and a visit, at the close of the meeting, to Vassar College and its observatory.

Various committee reports and items of business were considered by the society, among others the question of the daylight saving movement, and when an informal expression of opinion was called for, the vote stood

In favor of daylight saving	18
Opposed to the plan	22
Neutral	6
	46

Another matter in the same connection, which would affect only astronomers, was a proposal coming from England that the astronomical day begin at midnight instead of at noon as at present. A test vote showed that a large majority of the members present were opposed to the change, but after some parliamentary procedure it was agreed to refer the matter to a committee to make a report back to the society.

Officers were elected for the ensuing year as follows:

President—Edward C. Pickering.

First Vice-president—Frank Schlesinger.

Second Vice-president—W. W. Campbell.

Secretary—Philip Fox.

Treasurer—Annie J. Cannon.

Councillors—Ernest W. Brown, Edwin B. Frost, J. S. Plaskett, Joel Stebbins.

The next meeting of the society will be held at the Harvard Observatory about September 1, 1918.

Following is the list of papers presented at the meeting, the abstracts of which are published in *Popular Astronomy:*

Sebastian Albrecht: On the variation in spectral type of the fourth-class variable star *l Carinæ.*

S. I. Bailey: Note on the variable stars in the globular cluster *Messier 15.*

L. A. Bauer: A brief statement of the work of the Committee on Navigation and Nautical Instruments of the National Research Council.

R. R. Candor: A mechanical device for interpolation.

Annie J. Cannon: Distribution of light in stellar spectra.

J. B. Cannon: Note on two spectroscopic binaries.

W. A. Conrad: Note on a possible explanation of erratic jumps in clock rates.

R. H. Curtiss: Spectra of *Nova Geminorum No. 2* and other stars.

Ralph E. De Lury: A new form of spectrocomparator.

A. E. Douglass: The Steward Observatory of the University of Arizona.

A. E. Douglass: An optical periodograph.

Raymond S. Dugan: On the eclipsing variable *R Canis Majoris.*

W. S. Eichelberger: Eccentricity and longitude of perisaturnium of the orbits of *Enceladus, Tethys* and *Dione.*

W. S. Eichelberger: The obliquity of the ecliptic from the Sun observations made at the U. S. Naval Observatory, 1903–1911.

W. S. Eichelberger: The refraction at Washington

W. S. Eichelberger and F. B. Littell: Day observations minus night observations.

W. S. Eichelberger and H. R. Morgan: Comparison of Washington right ascensions with those of Newcomb, Auwers, Boss, Hedrick and Poulkowa, 1905.

W. S. Eichelberger and H. R. Morgan: Comparison of Washington declinations with those of Newcomb, Auwers and Boss.

George E. Hale: The best service of astronomers in time of war.

W. E. Harper: Notes on some spectroscopic binaries.

C. C. Kiess: On the presence of rare earths in *a Canum Venaticorum.*

E. S. King: Some recent work in photographic photometry.

Jacob Kunz and Joel Stebbins: Photo-electric observations of new variable stars.

C. O. Lampland: Measures of position of the nucleus of the great nebula in *Andromeda.*

C. O. Lampland: Recent observations of *Nova Persei 1901.*

C. O. Lampland: Photographic observations of the variable nebulæ N.G.C. 2261 and N.G.C. 6729.

F. B. Littell: Variation of latitude at the U. S. Naval Observatory.

W. F. Meggers: Photography of the solar spectrum.

Paul W. Merrill: Photography of the extreme red and infra-red portions of stellar spectra.

Joel H. Metcalf: A comparison of an 8-inch doublet with a 10-inch triple anastigmatic lens.

G. H. Peters: The photographic telescope of the U. S. Naval Observatory.

E. C. Pickering: Variation in light of asteroids.

W. F. Rigge: The total solar eclipse of June 8, 1918, as visible in the United States.

Luis Rodés: Direct application of Wulf's electrometer for recording the time sent by wireless telegraphy, and its connection with the potassium photo-electric cell to register the duration of totality in a solar eclipse.

H. B. Rumrill: A plea for the small telescope.

H. N. Russell: The masses of the stars.

H. N. Russell: On the calculation of the orbits of visual binaries.

H. N. Russell: New double star orbits.

F. H. Seares, A. Van Maanen and F. Ellerman: Location of the sun's magnetic axis.

H. T. Stetson: Some recent improvements in thermo-electric apparatus for photographic photometry.

Frank Schlesinger: Determination of stellar parallaxes at the Allegheny Observatory.

V. M. Slipher: Observations of the aurora spectrum.

V. M. Slipher: Spectrographic observations of star clusters.

R. Trümpler: Preliminary results on the constitution of the *Pleiades* group.

David Todd: Weather prospects along the central line of total eclipse, 1918, June 8.

A. Van Maanen: Discussion of the Mt. Wilson parallaxes.

F. W. Very: On a possible limit to gravitation.

Joel Stebbins,
Acting Secretary

SCIENCE

FRIDAY, NOVEMBER 16, 1917

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THE PRESENT CONDITION OF THE SOCIAL SCIENCES[1]

A NEW world is being born. Out of the chaos and the conflict of the present it seems certain that great social changes are bound to emerge. At the birth of this new social world it is the social sciences, not the physical, which must preside. Yet we who are interested in the development of the social sciences must candidly ask ourselves how far they are fitted to assist in the birth of a new social world. How far are they fitted to lead and to guide in the work of social reconstruction which must follow the World War? Do they command such general respect and confidence that the masses will turn to them for guidance to avoid the mistakes of the past and to make secure the foundations for a worthy civilization in the future? Are their leaders so united on fundamentals that, though they may differ regarding minor details, yet they substantially agree on the general direction which reconstruction in our political, economic, educational, domestic and general social life should take? Can, in brief, the social sciences present such an accurate body of information and of generalizations from facts that in this crisis sane men will turn to them voluntarily for guidance, much as they would to the physical sciences if any one were called upon to build a bridge?

Such questions as these are of more than merely academic significance. Germany has taught the world in this war the value and the possibilities of social organization;

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[1] An address before the local chapter at the University of Missouri of Alpha Zeta Pi, a society for encouraging scholarship and research in the social sciences.

and organization is destined to be a watchword of the future, whatever the outcome of this war. Organization of our political, economic, educational and general social life will be tried on a scale never before attempted, at least in English-speaking countries. Will the organization attempted be wise or otherwise? Wise social organization is evidently what we need, but it can not be successfully accomplished without scientific knowledge of our social life. Are we, then, as students of the social sciences prepared to give reliable scientific guidance in every field of social activity? Or have we only conflicting opinions to offer? We should face such questions as these candidly. The watchword of the present is "national service." Are we fully prepared to do our "bit" in the work of social reconstruction which our national welfare and security in the future demand? That, for us who are engaged in scientific and educational work along social lines, is a more important question than whether we are ready to do our "bit" in the war itself; for whether this war will prove to be a great victory for humanity and civilization will be evident, not upon the announcement of the terms of peace, but a generation or two thereafter.

What, then, are the social sciences ready to do for civilization?

The editor of *The Scientific Monthly*, in commenting on the papers presented before the Section for Social and Economic Science of the American Association for the Advancement of Science in the year 1915, published in the April, 1916, issue of that journal, said:

> An obvious difference exists between the eleven sections of the American Association devoted to the natural sciences and the one devoted to the social and economic sciences. The former are in the main concerned with the discovery of truth, the latter in the main with the expression of opinion.

While the work of the Social and Economic Section of the American Association may, perhaps, justly be held to be not representative of the best work in the social sciences, yet the general justice of this implied criticism of the social sciences can not be doubted. In spite of the labors of many eminent minds, in the main the social sciences, especially those of a theoretical nature, do remain still to-day in the realm of opinion rather than in the realm of accurate and verified truth. This is shown by the fact that not infrequently even in academic circles they are developed in the service of fads, social, political, metaphysical and methodological. This was once supposed not to be true of the older social sciences, such as economics and politics, but in the light of recent events it would be a very rash man who would affirm that even these older sciences have yet passed from the stage of opinion to that of verified scientific knowledge. It may possibly be said that when the whole world is in a condition of confusion and revolution, it is too much to expect that the social sciences will not also reflect this condition. But science is supposed to be something which, aiming as it does at the discovery of objective, verifiable knowledge, transcends the mere *Zeitgeist*. Besides, if the social sciences are in a state of confusion, the world can scarcely be expected to look to them to lead it out of its present confusion into a new and better day of peace, harmony and agreement as to the fundamentals of human living. It is true that the disagreements among the more carefully trained scientific social thinkers are much less than what the public suppose; but it is useless to deny that there are disagreements of the most fundamental sort, and that the social sciences suffer, as well as the world, from such disagreements. Of course, the lateness of their development and the complexity of the subject-matter with which they deal explains much of their unsettled condition and of the lack of harmony among their devotees. Nevertheless, this does not explain all. There are other conditions which explain the present backwardness of the social sciences, which are more remediable, and which it should be the object of this society to aid in removing. It is the purpose of this paper to point these out, and I believe that the chief among them is the failure of the leaders of the social sciences to develop an adequate, sound and generally accepted scientific method. Scientific method may not be very important in the laboratory sciences where mechanical instruments of precision often take the place of methods of reasoning; but in the social sciences "a sound method is alone competent to the uniform and constant discrimination of truth from error." As has been well said, what the microscope is to biology, or the telescope to astronomy, that a sound scientific method is to the social sciences. In other words, the tendency toward methodological "fads" or one-sidedness is one of the most serious impediments to the development of the social sciences, and at the same time one most easily removable.

What, then, may be regarded as a sound and adequate method for the social sciences? My thesis is that such a method must be an extension and an adaptation of the methods employed by the so-called natural sciences. If it be objected that this means materialism or at least "mechanistic interpretation" in the social sciences, the reply is that this is a mistake. Science builds itself upon no universal, *a priori* hypothesis. People who try to make it do so are imbued with the metaphysical rather than with the scientific spirit. The spirit and the method of all true science is matter-of-fact, inductive and pragmatic, not deductive and dogmatic. It takes the world as it finds it, correcting common sense only as it is shown to be in error. It explains phenomena, not by reference to some universal abstract principle, such as mechanical causation, but by describing fully all the conditions essential to their appearance. But this is exactly what the social sciences do also. They also seek to explain the phenomena with which they deal by observing and describing all the conditions which seem to be in any way connected with their appearance. Science is therefore one, even though reality may be complex; and the same general spirit pervades all science, even though different methods of investigation and research have to be developed and applied in different realms of phenomena. Moreover, inasmuch as the universe is interdependent in all its parts and forms a working unity, it follows, as Comte long ago pointed out, and as every worker in the natural sciences practically acknowledges, that the more complex sciences are dependent upon the less complex, and the more specialized upon the more general.

An immediate corollary from these conclusions is that the social sciences should preserve the point of view and utilize the results of the natural sciences; that is, they should preserve the same matter-of-fact method and build themselves upon the antecedent sciences as their basis. This is in no sense to surrender the inductive spirit of science. The inductive spirit is behind all science, and when a worker in a more complex science borrows a principle or a truth from a simpler science and applies it in his own field, he is not thereby giving up the inductive spirit of science, even though for the time being he is working deductively. For there is no reason why a student of society should have to work out for himself independently truths which have already been discovered through inductive processes by investigators in other realms. The true inductive spirit is not opposed to the proper use of deduction. What passes for induction in the social sciences—the mere gathering and amassing of facts—is often but superficiality under another name. If there is any hope of the social sciences getting beyond the stage of mere socially approved opinions, and of coming to substantial agreement on fundamental issues, it must be through basing themselves upon the established results of antecedent sciences, particularly of biology and psychology. Yet the natural-science point of view is largely lacking in much of the literature of the social sciences to-day. Many of their devotees seem to think that the world of human society, of social phenomena, is a thing apart, to be studied and understood by itself. This is noticeable, not only in politics and in economics, but also in sociology, where for a number of years a considerable school have openly maintained that the biology and psychology of the individual have little effect upon the group or social life, and that therefore the social sciences can not base themselves upon biology and psychology. Even the most notable book published in sociology during the present year—Professor R. M. MacIver's "Community"[2]—though in many ways a remarkable book, showing both penetration and breadth of view, fails to recognize explicitly the close connection between the natural and social sciences and denies altogether that sociology should in part be based upon psychology.

But two of the social sciences at the present time may be said to have attained even to a partly adequate method if judged by the standards which have been just set forth. Both these sciences, however, are preliminary and methodological to the more theoretical and applied social sciences. They are anthropology and history. Anthropology, on account of its close connections with zoology, especially in its physical sections, has long had the point of view of the natural sciences, though for a long time its work was narrowly individualistic. The new school of social anthropologists, however, have developed a social point of view while making full use at the same time of modern psychology. The achievements and methods of this school we shall touch upon later. Suffice to say that modern anthropology has demonstrated its right to a place among the social sciences, and in its carefully worked out and highly conscious methods it is perhaps the best equipped of all of them. This explains its rapid recent advance. But dealing as it does with human origins in general and with social and cultural origins in particular, its work from any practical viewpoint must be regarded as preliminary to the other social sciences.

History, the oldest of the social sciences, has long since worked out an elaborate methodology for the critical determination of events, conditions, and institutions in the human past. But only recently has a new school of historians, led chiefly by Professor J. Harvey Robinson in this country, attempted to bring history into vital touch with the natural sciences, on the one hand, through anthropology, and with the theoretical social sciences on the other, through social psychology. From this "new history" we can expect much; but from the standpoint of the theoretical and applied social sciences history is chiefly important as a method of approach to their problems. It is, indeed, of vital importance; and I know of no surer touchstone of sanity in the social sciences than the amount of consideration which is accorded to human history. But every historian should know, what every economist, sociologist, and political scientist does know, that the historical method has not yielded the results which were once hoped from it. By itself the historical method is inadequate from the very nature of recorded human history. The historical evidence of the past is at best but fragmentary and fails to yield all the knowledge which we need for guidance in the complex social conditions of the present.

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[2] The Macmillan Company, 1917.

This perception has led to the search for, and the emphasis upon, other methods of social research and investigation. Chief among these has been statistics. Statistics has had many enthusiastic advocates as *the* method of the social sciences, both among economists and sociologists, a recent advocate going so far as to say that the statistical method bears much the same relation to the social sciences that the experimental method bears to the physical sciences.[3] There can be no doubt that statistics presents the one means of measuring social facts upon a wide scale, and so of rendering our knowledge of mass movements exact. In so far as exact measurements are needed in the social sciences (and they are needed not less than in other sciences), the statistical method must remain a highly important part of the methodology of the social sciences. It is greatly to be regretted, therefore, that as yet we possess adequate statistics of only very small sections of our social life; and it is manifestly our duty as students banded together to promote scholarship in the social sciences to do all that we can to promote the accurate collection and study of social statistics. However, apart from the fact that statistical methods have still to be enormously developed before they are susceptible of application to the general problems in the field of the social sciences, it is evident that there are many problems in political science, jurisprudence, sociology and other social sciences which by their nature are not amenable to statistical treatment. It is noteworthy, moreover, that the natural sciences have made but a subordinate use of statistics. It is true that they have other instruments of precision, but the experimental method, so far from closely resembling the statistical method, is rather mere observation under controlled conditions. It would seem, therefore, that the nearest approach to it in the social sciences would be the direct observation of social life under mentally controlled conditions It is true that social conditions can rarely be fully controlled, but observation by trained observers can be, and the results can be checked up with the aid of the historical, comparative, and statistical methods.

A little over a dozen years ago the practical needs of social workers for more accurate and scientific knowledge of the social conditions in the communities in which they worked led to their instituting programs of social investigation which they called "social or community surveys." One of the first and most extensive of these "surveys" was the well-known "Pittsburgh Survey." A great number of these surveys have now been made in widely scattered communities, and the movement has become specialized, so that now we have surveys of different sorts, such as "health surveys," "educational surveys," "industrial surveys," "agricultural surveys," etc. It will be noted that the movement arose entirely to meet practical needs, and that there was no thought of making a contribution to scientific methods of studying the social life. At first, the movement was narrow. The "survey" was confined largely to the material aspects of the social life, such as sanitation, housing, wages, etc. Moreover, the survey was supposed to be an entirely local and community affair, and though statistical accuracy was emphasized, but little attention was paid to history and comparison. How, then, does this movement, which many scientific men have doubtless looked upon as a passing fad, contain the promise and the potency of an adequate method for the social sciences? Science demands world-wide, or universal, generalizations, whereas the survey is a local or community affair.

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[3] See the suggestive articles on "The Experimental Method and Sociology" by Professor F. Stuart Chapin in the February and March, 1917, issues of *The Scientific Monthly*.

Before answering this question it may be well to point out that social workers, though they have popularized it, were not the first to employ the "survey" method. The anthropologists may probably claim that honor. The old-time anthropologist was a laboratory or library worker, relying largely upon the reports of travellers and missionaries for his knowledge of customs and institutions. The new anthropologist is a field worker. Moreover, he works cooperatively, organizing expeditions which undertake extensive "anthropological surveys," investigating minutely the customs, institutions, ideas, beliefs, and history of the population of a given region. Such have been, for example, the Jesup North Pacific Expedition and the Torres Straits Expedition. Very valuable scientific results have come from such anthropological surveys, especially when their facts have been compared one with another.

Now this illustration shows that survey methods are not limited, that surveys properly made are of far more than local significance, and that the most valuable scientific facts and principles can be secured through the careful survey of different communities and their comparison. The survey method might, indeed, properly be called the laboratory method of the social sciences; for the world of human beings, the *community,* whether large or small, is the only possible laboratory which the social sciences can employ. Like laboratory methods in the natural sciences, this intensive study of the social life permits the isolation of phenomena and at the same time their study by a combination of methods. It is as if nature had set a great many experiments going at once in many different laboratories, and the scientific observer had only to devise adequate methods of checking up the results. It is not necessary, of course, that such inductive study should go on indefinitely for certain results, as some have claimed; on the contrary, a single accurate observation may give a clue which a comparatively small number of similar observations may suffice to establish as accurate scientific knowledge. Neither need the community which is studied by the survey method be a small, local area. It can be of any size, provided we perfect our methods of observation. Why should not the survey method be extended to the life of the whole nation? The Census Bureau, it may be said, has long undertaken such work, but not on the scale demanded by the social surveyor, much less by the scientific student of society. Moreover, social life is no longer national, but international. What is needed most of all, of course, is a survey of our whole civilization. Such a vast cooperative undertaking may, at first thought, seem fantastic; but it is surely the logical goal of the social sciences on the side of induction; and practically we surely need to know much more about the conditions of our whole civilization than we have known if rational social control over human life is to be made possible.

We are now prepared to see that the survey method is not opposed to the historical method of approaching social problems. On the contrary, the survey method includes the historical method as a necessary part. The survey must be extended in time if it is to be of scientific value. The statistical method is also evidently a part of any adequate survey work. Exact measurement of all phenomena that can be measured is needed. The survey method is, indeed, but a name for the proper combination of all inductive methods in the scientific study of the social life. But therein lies its promise of becoming an adequate method for the social sciences of the future; for no method will be adequate in their complex field which is not synthetic. As their inductive instrument the survey method of studying social facts will not preclude the social sciences from making full use of psychology, biology and geography. For social facts could not be interpreted, as we have seen, without the use of these antecedent natural sciences; and hence any method to be fully scientific must be a synthesis of inductive results

It may be objected that the use of such a complex, synthetic method in the social sciences will be beyond the ability of ordinary minds. That I do not believe. To be sure, the level of scholarship in the social sciences will have to be raised before it can be used successfully. I am not, however, among those who believe that the present level of scholarship in the social sciences is lower than in the so-called natural sciences. I believe the contrary. But I would urge that the grave responsibility resting upon us as leaders of social thought, as well as the complexity of the problems with which we deal, demands higher standards of scholarship among us than among the students of the natural sciences. In this grave crisis of our civilization it is time that we recognize this fact. It particularly demands that we be more than mere specialists in economics or administration, in history or anthropology, in education or law; but that we have that breadth and depth of scholarship which will enable us to see on all sides of, and to the bottom of, our particular problem.

The practical difficulties, however, of employing such a comprehensive, synthetic instrument of social investigation can not be ignored. The survey method of social investigation is still very far from being developed to the point which I have described. It can not be so developed without the aid of governmental and educational agencies. It is the same with the social sciences as with all sciences, that they can not flourish without the aid and encouragement of society at large, especially through governmental and educational institutions. I believe, however, that such aid will be forthcoming if we keep our standards of scholarship sufficiently high, and work together to show the need for the development of all the social sciences.

In this crisis, therefore, let us who are students of social life close up our ranks and work together for the establishment and diffusion of that accurate social knowledge for lack of which the world seems almost on the point of perishing; for this crisis has clearly demonstrated that it is to the social sciences, not to the physical sciences, to which the world must look for its salvation. And it is upon us who are students of the social sciences that the responsibility for their future development and usefulness to humanity must rest.

Charles A. Ellwood
University of Missouri

WORK OF THE NATIONAL RESEARCH COUNCIL

Major R. A. Millikan, vice-chairman of the National Research Council, wrote, on September 7, a letter to Dr. Cary T. Hutchinson, secretary of the Engineering Foundation, reviewing the work of the council. The letter as "edited for publication" in the *Proceedings* of the American Institute of Electrical Engineers is as follows:

The following is a statement of some of the work of the National Research Council, condensed with difficulty on account of the great variety and scope of the council's activities.

All of the work of the Research Council that touches upon Army or Navy problems is carried on with the advice, cooperation or control, as the case may be, of the representatives of the various departments of the Army or Navy under which such work comes.

The council has cooperated in the establishment and organization of the submarine experimental work at Nahant and has also established a very active submarine station at New London, another at San Pedro, California, and has been instrumental in the organization of groups working at New York, Chicago and Madison, Wisconsin.

There has resulted a great practical advance in the art of submarine detection which it is not desirable to go into further.

The physics committee of the council has distributed to various groups twenty or more large problems in physics, which are being actively worked upon and some of which have already been solved. Among the latter are the location of aircraft by sound, the development of fire control for anti-aircraft guns, telephoning between airplanes, protection of balloons from ignition by static charges and the development of new and improved methods of measuring muzzle velocities.

The chief officer of the signal corps of the Army has asked the Research Council to act as the Division of Science and Research of the Signal Corps, and in this capacity the council has organized a sound ranging service in the signal corps, a new meteorological service in the signal corps, and is now drawing specifications for scientific instruments to be used on airplanes. It has sent a dozen of the best physicists in the country to France to aid the American Expeditionary Forces with their scientific knowledge and is selecting a personnel of several hundred men who are to be engaged in the scientific services of the Army and Navy.

The chemistry committee has perfected an elaborate organization for the handling of all of the chemical problems which arise in the Army and in the Navy, and it has distributed some 150 chemical problems which are being attacked in the chemical laboratories of the country.

The psychology committee has presented to the Secretary of War and the adjutant general a vast program for the selection of officers for the Army from officers' reserve camps and for the classification of drafted men. In fact it has called in most of the best known psychologists of the country and has organized them and employment experts into a large group in whose hands the War Department has placed the largest responsibilities regarding the examination and selection of men.

The medical committee has enlisted the services of a large number of medical men of the country both in medical research problems and in the regular work of the sanitary corps of the Army.

The engineering committee has contributed in no small degree to the development of devices for the protection of ships from submarines. It has organized a large group which are now working on the development of steel protective devices for use of the soldiers at the front, and through cooperation with the National Advisory Committee for Aeronautics it has carried on extensive and important researches in the development of airplanes and airplane engines.

Turning to the work of the special committees of the council, the nitrate committee has made an elaborate study and report which has been made the basis for the expenditure by the government of large sums of money upon the erection of a nitrate plant.

The gas warfare committee has had for six months 120 chemists working on the problems of gas warfare and the results already attained have been of the utmost importance—so important that the Army and Navy have placed large appropriations at the disposal of this committee for its researches.

The optical glass committee, by taking from the research laboratories like the geophysical laboratory and the bureau of standards, a dozen more silicate chemists and putting them directly in the works of the Bausch and Lomb Company and the Pittsburgh Plate Glass Company, has in six months' time developed in America the production of optical glass from nothing up to 20,000 pounds a month and in two months more this figure will have been multiplied two or three fold.

The psychiatry committee has established abroad a laboratory for the study of shell shock.

The foreign service committee, which the council sent abroad at once upon the outbreak of the war, was wholly responsible for the sending back to this country of a French, English and Italian scientific mission, which brought with them the contributions which science had made to the war, both in the matter of instruments and methods, and unquestionably saved months of time in putting the United States abreast of the European situation, as regards modern scientific methods in warfare. It is difficult to overestimate the stimulus to American participation in the war which resulted directly from the action of the Research Council in sending abroad at once this foreign service committee composed of seven of the best scientists in the country.

These are a few of the results which have followed from the assistance which the engineering foundation gave in the bringing into being of the National Research Council. It is hoped that they are only a small part of the results which will have been attained by the end of the second year of its existence.

SCIENTIFIC EVENTS

CELEBRATION IN HONOR OF DR. HENRY FAIRFIELD OSBORN

On the afternoon of September 29 a large and informal gathering of friends surprised Dr. Henry Fairfield Osborn at his home at Garrison-on-Hudson in honor of his sixtieth birthday. The visit had originally been planned for August 8, his birthday, but was necessarily deferred until September 29, which chanced to be the thirty-sixth anniversary of his marriage with Mrs. Osborn. The American Museum of Natural History was represented by Mr. Madison Grant of the board of trustees, by the members of the scientific staff and their wives, by the members of the department of vertebrate palæontology and of the administrative and technical staffs and their wives. The New York Zoological Park and the New York Aquarium, Columbia University and Princeton University were also represented. The weather was favorable so that the arrangements for luncheon on the lawn were enjoyably carried out. After the luncheon Professor Edmund B. Wilson, of Columbia, read congratulatory messages from Colonel Theodore Roosevelt, President Nicholas Murray Butler, and Mayor Mitchel, and presided at the addresses, the speakers including Mr. Madison Grant, Professor McClure of Princeton, Mr. William Church Osborn, Professor Bashford Dean, and Dr. Frank M. Chapman. Dr. F. A. Lucas gave a discourse on "Birthdays," after which he presented to Professor Osborn an illuminated message of congratulation bearing forty-six signatures. The text of this message and the signatures were as follows:

TO

HENRY FAIRFIELD OSBORN

Your friends, who are bound to you by many years of treasured association, bring this message of congratulation upon your sixtieth birthday.

We have followed with increasing admiration the progress of your labors during the past forty years in an ever widening field of science. We are proud of the splendid record of your achievements: admirable researches accomplished and in progress, great institutions of science and education founded and fostered, high scientific ideals nobly illustrated and practised.

May the coming years further expand the orbit of your influence. May your spirit of high enthusiasm, thoroughness and unwearying industry, sustained by the cordial sympathy and coöperation which you have always shown towards others, become more and more characteristic of American science.

J. A. Allen,
L. P. Gratacap,
George F. Kunz,
E. O. Hovey,
Frank M. Chapman,
Jonathan Dwight,
Roy W Miner,
W. D. Matthew,
Walter Granger,
Barnum Brown,
A. Hermann,
William K. Gregory,
Frederic A. Lucas,
Theodore Roosevelt,
N. L. Britton,
Geo. H. Sherwood,
R. W. Tower,
Mary C. Dickerson,
Pliny Earle Goddard,
Clark Wissler,
Frank E. Lutz,
Fred H. Smyth,
Geo. N. Pindar,
Edmund B. Wilson,
Wm. H. Carpenter,
Bashford Dean,
Henry E. Crampton,
T. H. Morgan,
Gary N. Calkins,
J. Howard McGregor,
W. B. Scott,
Chas. W. Mead,
Chester A. Reeds,
John Treadwell Nichols,
Cleveland H. Dodge,
Madison Grant,
Percy R. Pyne,
W. T. Hornaday,
Chas. H. Townsend,
C. W. Beebe,
Raymond L. Ditmars,
S. H. Chubb,
Albert Thomson,
E. S. Christman,
A. E. Anderson,
H. Lang.

August 8, 1917

THE LABORATORY OF THE U S. FISHERIES BIOLOGICAL STATION AT WOODS HOLE

The work of the staff at the station of the Bureau of Fisheries at Woods Hole during 1917, has been concentrated during the summer on problems directly bearing on the conservation of food fishes and the utilization of marine forms not now appreciated in this country as food. Researches on the best methods of desiccating fish for storage, on the rehydration of dried fish and on the food value of such preparations were undertaken by Dr. G. G. Scott, of the College of the City of New York. Observations on the relation of parasites, especially nematodes, to the edible qualities of food fishes were made by Dr. Edwin Linton of Washington and Jefferson College. Investigations on the bacteriology of food fishes during refrigeration and on the methods of combating "rust" in salt fish were carried on by Dr. W. W. Brown, of the College of the City of New York. The food value and the possible methods of marketing squid, the utilization of the waste products of grayfish, optimum methods of canning as applied to fish, the utilization and preservation of shark and certain problems concerning the nutrition of oysters were investigated by Dr. P. H. Mitchell, of Brown University. Mr. A. E. Barnard, Mr. F. R. Dieuaide, Mr. B. N. Harris and Mr. H. E. Stewart were scientific assistants. Dr. P. H. Mitchell acted as director. The laboratory opened on June 20 and closed September 8.

THE AMERICAN PSYCHOLOGICAL ASSOCIATION

THE council of the association has voted unanimously to hold the annual meeting at Pittsburgh instead of Ann Arbor, as was previously announced.

The Pittsburgh meeting will be held on Thursday to Saturday, December 27, 28 and 29. The sessions will take place in the school of applied design of the Carnegie Institute of Technology. The sessions will overlap the meetings of the American Association for the Advancement of Science which holds its convention in Pittsburgh, from December 28 to January 2. Sections H and L of the American Association for the Advancement of Science will meet in rooms in the same building, and it is probable that there will be joint sessions with these sections. Arrangements will be made for visiting the psychological laboratory and psychological clinic at the University of Pittsburgh, which is near by. The meeting place is within walking distance of the hotel headquarters at Hotel Schenley. In order to reach the meeting place by street car, the members should take a car running to Forbes Street and Woodlawn Avenue and leave the car at Woodlawn Avenue. Those who come to Pittsburgh from the East on the Pennsylvania Railroad and wish to go directly to the meetings, should leave the train at the East Liberty Station and take a street car at the corner of Penn and Shady Avenues.

The annual dinner will occur on Thursday evening, December 27, at the Pittsburgh Athletic Association, which is across the street from the hotel headquarters. The dinner will be followed by the annual presidential address and smoker.

Hotel headquarters will be at the Schenley which is also to be the hotel headquarters for the American Association for the Advancement of Science. It is the only hotel immediately accessible to the meeting places; the other hotels are located in the business district which is from twenty to thirty minutes distant, by street car. Professor Miner, as local member of the executive committee, will be glad to arrange for rooms in the dormitories at the Carnegie Institute of Technology or in neighboring boarding houses, for those who may so prefer. Luncheons will be served at the Carnegie Institute of Technology.

The program will be sent to members on December 1. In order to have it finished by that date, all titles, together with abstracts, must be in the secretary's hands by November 24. It is proposed as in previous years, to print the abstracts in advance of the meeting. They will then be available for distribution among the members in attendance. The attention of the members is called to a motion defining the functions of the program committee and the method of submitting papers to be read at an annual meeting, which was recommended by the council and passed by the association at its last annual meeting. The motion reads as follows:

> That the committee be granted full power in the selection and rejection of papers;
>
> 2. That no title shall be accepted unless accompanied by a summary of the paper giving the main points to be developed; that the summary shall be submitted typewritten in triplicate and ready for printing; that it shall not exceed one printed page of the *Proceedings*, and shall contain no tables or drawings;
>
> 3. That all titles and summaries shall be in the hands of the secretary on a certain date to be set by the committee and announced to members of the association;
>
> 4. That the titles of rejected papers shall not be listed on the program, nor their summaries published in the proceedings.

The secretary is authorised to arrange for the payment of transportation charges on new apparatus for research, useful charts and demonstration devices which the members may be willing to display. The consignments should be shipped to Dr. J. B. Miner, division of applied psychology, Carnegie Institute of Technology. A convenient room for exhibiting apparatus will be provided. Members, however, should supervise the setting up of their apparatus and the re-packing of it, so as to relieve the local committee from responsibility for possible injury. There will be also an opportunity to exhibit mental and educational tests, with charts or tables of results and directions for giving each test. These will be placed with the apparatus exhibit.

H. S. LANGFELD,
Secretary.

HARVARD UNIVERSITY

THE SECTION OF EDUCATION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION L of the American Association for the Advancement of Science will hold its annual meeting at Pittsburgh, on December 29 and 31, and January 1.

The general subject of the program is the scientific study of educational problems. Any paper dealing with a topic of this character will be acceptable. This year the section will be particularly glad to receive papers dealing with

1. Studies of the Reliability of Educational or Mental Tests.
2. Correlations between Educational Abilities.
3. New Tests for the Measurement of Educational Products.
4. Studies of the Relative Efficiency of Different Methods of Teaching.
5. Scientific Determinations of Desirable Content for Courses in Study.
6. Studies of the Diagnosis and Remedy of Educational Defects.

Membership in the Section is open to all interested in education, and the sectional committee will be glad to consider any papers submitted. You are hereby invited to take part in the meetings of the Section, or, if you are unable to contribute a paper yourself, to aid in the work of the section by bringing this invitation to the attention of any person known to you to be attempting the scientific evaluation of the effects of any educational experiments in which they may be engaged.

All titles should be sent to the secretary by November 24, before if possible.

S. A. COURTIS,
Secretary Section L

SCIENTIFIC NOTES AND NEWS

A MEMORIAL meeting for Professor Wm. Bullock Clark was held at the Johns Hopkins University on the Sunday afternoon of November 4, President Frank J. Goodnow presiding. The speakers were Dr. Charles D. Walcott, the secretary of the Smithsonian Institution; Mr. R. Brent Keyser, the president of the board of trustees of the university; Professors Harry Fielding Reid and J. S. Ames, of the faculty, and Judge J. T. C. Williams, of the Baltimore Juvenile Court.

DR. ALONZO E. TAYLOR, of the University of Pennsylvania, now of the food administration at Washington, is a member of the American Commission to the Allied War Conference to be held in Paris on November 15.

PROFESSOR A. O. LEUSCHNER, director of the astronomical department of the University of California, at Berkeley, has been delegated by the director of instruction in the navigation schools of the United States Shipping Board, to administer the details of instruction on the Pacific coast and in particular to provide qualified instructors.

DR. F. B. KINGSBURY, assistant professor of physiological chemistry in the University of Minnesota, has been granted leave of absence for the duration of the war. He has been commissioned first lieutenant in the sanitary corps of the Army and will be directly under Major John R. Murlin, of the Food Division. His work at first will be in the army medical school, in preparation for the nutritional survey of the army camps and cantonments here and at the front.

DR. ALEXANDER HAMILTON RICE, the explorer, has been commissioned senior lieutenant in the naval reserves. He will have charge of the departments of astronomy and navigation in the Naval Cadet School at Newport, R. I.

Professor Richard W. Husband, of Dartmouth College, whose services have been loaned to the State Committee on Public Safety, will write a complete history of New Hampshire's part in the war. Men have been named to compile statistics in the cities and towns.

Popular Astronomy states that Dr. F. C. P. Henroteau, of Brussels, has been appointed Martin Kellogg Fellow in the Lick Observatory for the year 1917–18. Since leaving Brussels, in August, 1914, Dr. Henroteau has spent fourteen months in work at Stonyhurst College Observatory, in England, and nearly a year and a half at the Detroit Observatory, Ann Arbor, Michigan. Mr. Holger Thiele has also been appointed fellow in the observatory for the year 1917–18 and is now in residence. Mr. Thiele was assistant in the observatory at Bamberg, Bavaria, in 1900–01, in the observatory at Copenhagen 1901–07 and in the observatory at Bergdedorf, Hamburg, from 1908 to February, 1917.

Dr. J. C. Witt, for the past two years engaged in industrial research at the Bureau of Science, Manila, has been appointed technical director of the Rizal Cement Company. This company operates the only cement mill in the Philippine Islands.

At the Museum of the University of Pennsylvania, Dr. G. B. Gordon, the director of the museum, is away on a six months' leave of absence and Dr. W. C. Farabee has been appointed acting director in his place; Mr. H. U. Hall, assistant curator of the section of general ethnology, is now with the Second Pennsylvania Field Artillery at Camp Hancock, Augusta, Georgia; Mr. B. W. Merwin, assistant curator in the American section, has left the museum for military service, and is stationed at Macon, Georgia.

Mr. W. Elmer Ekblaw of the University of Illinois, has been appointed research associate in geology in the American Museum of Natural History for the years 1917 and 1918, in recognition of his record and services on the Crocker Land Expedition during the years 1913 to 1917.

Honorary membership in the Chemists' Club, New York City, was conferred upon Professor Grignard, of the French Mission, at a joint meeting of the New York Section of the Society of Chemical Industry, American Chemical Society and the American Electrochemical Society, on October 19. An address was made by Professor Grignard.

Owing to the resignation on account of ill health of Mr. W. B. Worthington, president of the Institution of Civil Engineer of Great Britain, Mr H. E. Jones, a vice-president, has been nominated president for the ensuing year.

At the annual statutory meeting of the Royal Society of Edinburgh, held on October 22, the following office-bearers and members of council were elected: President, Dr. J. Horne; vice-presidents, the Right Hon. Sir J. H. A. Macdonald, Professor R. A. Sampson, Professor D'Arcy Thompson, Professor J. Walker, Professor G. A. Gibson, and Dr. R. Kidston; General Secretary, Dr. C. G. Knott; Secretaries to Ordinary Meetings, Professor A. Robinson and Professor E. T. Whittaker; Treasurer, Mr. J. Currie; Curator of Library and Museum, Dr. A. C. Mitchell; Councillors, Dr. J. H. Ashworth, Professor C. G. Barkla, Professor C. R. Marshall, Dr. J. S. Black, Sir G. A. Berry, Dr. J. S. Flett, Professor M. Maclean, Professor D. Waterson, Professor F. O. Bower, Professor P. T. Herring, Professor T. J. Jehu, and Dr. A. Lauder.

Professor E. C. Jeffrey, of Harvard University, gave a lecture on "The Origin of Coal" at Wellesley College, on November 6.

The three hundred and thirty-fourth meeting of the American Institute of Electrical Engineers was held in the Auditorium of the Engineering Societies Building, New York, on November 9. The paper of the evening was entitled "An experimental method of obtaining the solution of electrostatic problems with notes on high-voltage bushing design," by Mr. Chester W. Rice, of the General Electric Company.

WE learn from *Nature* that on October 10 a memorial tablet was unveiled at Oxford, commemorating the life and work of Roger Bacon. The tablet has been fixed to the old wall of the city, dating from early in the thirteenth century, close to the site of the Grey Friars Church in the precincts of which Roger Bacon was buried. The church has long since disappeared, but the position of the burial ground, though not the exact spot of Bacon's grave, is known. After the celebration at Oxford in 1914 of the seven hundredth anniversary of Bacon's birth, it was thought fitting that in addition to the statue then created in the University museum, a permanent and public memorial should be set up as near as possible to the site of the Franciscan friary in which Bacon passed so many years of his strenuous life. This has now been accomplished.

THE death is announced, at seventy-three years of age, of Professor A. J. F. Dastre, director of the laboratory of animal physiology at the Sorbonne, and a member of the Paris Academy of Sciences.

DR. ADDISON, the minister of reconstruction of Great Britain, has appointed a committee to consider and report on questions connected with the supplies of raw materials which will be required by British industries for the purpose of restoring and developing trade after the termination of the war and the best means of securing and distributing supplies, due regard being had to the interests of the Allies. The committee, which will be known as the Central Committee of Materials, consists of the following members: Sir Clarendon Hyde (chairman), Sir H. Birchenough, K.C M G., Mr. Cecil Budd, Sir C. W. Fielding, K.B.E., Sir H. Babington Smith, K.C.B., Mr. W. Thorneycroft and Mr. A. Weir. The secretary is Mr. J. F. Ronca, who should be addressed at the Ministry of Reconstruction, 2 Queen Anne's Gate Buildings, Westminster, S.W. 1.

WE learn from *Nature* that a meeting was held at the Manchester School of Technology on November 10, under the chairmanship of Dr. Alfred Rée, for the purpose of inaugurating a British Association of Chemists. The objects of the proposed association are (*a*) to obtain power to act as sole registration authority for all chemists; (*b*) to have the word chemist legally redefined; (*c*) to safeguard the public by obtaining legislation ensuring that certain prescribed chemical operations be under the direct control of a chemist, and (*d*) to raise the profession of the chemist to its proper position among the other learned professions, so that it may attract the attention of a larger proportion of the best intellects, and thereby secure a supply of highly trained chemists adequate to the industrial needs of the country. The secretary of the Provisional Committee is Mr. R. E Crowther, 3 Langford Road, Heaton Chapel, near Stockport.

AT the Pittsburgh meeting of the American Association for the Advancement of Science, Section G—Botany, will hold on Saturday, December 29, at 2 P.M., a joint session with the Botanical Society of America and the American Phytopathological Society. The program will be as follows.

"The near future of botany in America" (vice-presidential address), C. Stuart Gager.

Invitation Papers Relating to War Problems in Botany

"A new wheat disease in relation to the national food supply," Erwin F Smith.

"Plant disease survey work and its relation to food production." G. R. Lyman.

"Forestry problems after the war." I. W. Bailey.

"War work of the botanical committee of the National Research Council," John M. Coulter.

THE course of scientific lectures of the California Academy of Science have been continued on Sunday afternoons at 3 o'clock in the Auditorium of the Museum in Golden Gate Park. Announcements for the month were as follows:

October 28. Mr. Henry H. Hart, assistant city attorney. San Francisco, Hawaii Nei. (Illustrated.)

November 4. Dr. Bailey Willis, head, department of geology, Stanford University, The Chinese at home. (Illustrated.)

November 11. Professor G. A. Coleman, college of agriculture, University of California, Natural history and manipulation of bees. (Illustrated by moving pictures.)

November 18. Professor George D. Louderback. department of geology, University of California. Geological explorations in China. (Illustrated.)

These lectures are well received by the people of San Francisco and the number of regular attendants is particularly noteworthy. The auditorium of the academy has been filled to its capacity several times during the past month.

The forty-second year of the *Ecole d'Anthropologie de Paris* opened on November third with courses offered as follows:

1. R. Anthony, Development of the brain in man and the apes.
2. L. Capitan, Art and architecture during the neolithic and protohistoric periods.
3. G. Herve, Ethnology and ethnography in France during the eighteenth century.
4. P. G. Mahoudeau, The precursors and the authors of evolution: Buffon, Lamarck, Darwin.
5. L. Manouvrier, Ethnic psychology.
6. A. de Mortillet, Burial customs among ancient and modern primitive races.
7. C. Papillault, Psycho-social values and sophisms.
8. F. Schrader, Geographic causes of rapprochement and differentiation among human groups.—Evolution of the old world.
9. J. Vinson, Primitive languages, popular language, folk-lore.

In addition there are two short courses of eight lectures each on: (1) The survival of primitive industries, by D. Bellet; and (2) Falsehood from the viewpoint of anthropology and criminology, by Paul-Boncour.

UNIVERSITY AND EDUCATIONAL NEWS

Yale University receives the sum of $300,000 by the will of Mrs. Charles W. Harkness, who died on December 6, 1916.

Harvard University has received a bequest from the estate of Horace Davis amounting to $10,000, the income of which is to be used for the purchase of books for the Harvard University Library relating to the Northern Pacific Ocean and its shores. The university has also received a gift of $50,000 from Mrs. S. Parkman Blake, the income to be used "for the care of the yard or other grounds of the university." The gift is a memorial to her husband, S. Parkman Blake, of the class of 1855, and to her son, Robert Parkman Blake, of the class of 1894.

In accordance with the terms of the will of the late Richard Black Sewall, of Boston, there are public bequests amounting to $380,000, and the residuary legatees are Harvard University and Yale University. The Boston Museum of Fine Arts, the Massachusetts Institute of Technology, the Worcester Polytechnic Institute, Williams College and Amherst College each receives $30,000. Tuskegee Institute and Hampton Normal Institute are each given $5,000.

The Converse Library at Amherst College was dedicated on November 8. The new $250,000 building is the gift of Edmund C. Converse, of New York, in memory of his brother, James B. Converse, who was a member of the class of '67 at Amherst. Mr. Converse, Herbert Putnam, librarian of Congress, and George A. Plimpton, of New York, president of the college board of trustees, took part in the exercises.

The University of Rochester has expanded its work in psychology. Quarters are now provided for an experimental laboratory, and are thoroughly equipped for experimental purposes. Two experimental courses will be given during the present year. One course, extending through the college year, emphasizes the psychology of the sense organs and more complex mental processes. The second course takes up the study of comparative psychology. Quarters for animal experimentation have been provided. The course is under the charge of L. A. Pochstein, Ph.D. (Chicago).

Arthur L. Foley, head of the department of physics of Indiana University, has been elected research professor in the Waterman Institute, the first to be elected to this position. The institute was founded and endowed a few years since by Dr. Luther Dana Waterman, a retired physician of Indianapolis. It is under the control of the trustees of Indiana University and is in part supported by the university. The entire income of the Institute is to be devoted to research. Professor Foley retains charge of the physics department of the university, but is relieved of all teaching duties.

Dr. H. D. Senior, head of the department of anatomy of New York University and Bellevue Medical College, is in England engaged in military medical work. Dr. F. W. Thyng is acting professor of anatomy and head of the department in Dr. Senior's absence, and has charge of histology and embryology. Dr. E. R. Hoskins is acting assistant professor and is in charge of gross anatomy and neurology. Dr. J. L. Conel and Dr. Margaret M. Hoskins are instructors in histology and embryology and Dr. C. Hield is instructor in gross anatomy and neurology. The school year began with 190 students in the first-year class, an increase of 13 over last year.

Warren G. Waterman has been appointed assistant professor of botany at Northwestern University, having completed his work at the University of Chicago, where he received the degree of doctor of philosophy at the August convocation.

Professor D'Arcy Wentworth Thompson, professor of natural history, University College, Dundee, has been appointed to the chair of natural history at St. Andrews, vacant through the retirement of Professor W. C. McIntosh.

DISCUSSION AND CORRESPONDENCE

BOTANY AND COMMON NAMES OF PLANTS

To the Editor of Science: Those who favor using the common names of plants, instead of the technical names, probably do not realize the confusion that would result in most instances, where exactness is necessary or desirable, if their suggestions were followed. Imagine the pharmacist relying solely upon the common names in selecting such drugs as mandrake, bitter-sweet, coltsfoot and sarsaparilla. Some of his patrons would surely be poisoned and others would die for want of the proper remedy. Scientific names were given to plants for the express purpose of facilitating exact reference to them and it is a mistaken kindness to teach children and others the common names under the impression that the technical terms are too difficult. Any child who can be taught to say rhinoceros, chrysanthemum or rhododendron can be taught the scientific names of plants and thereby advanced on the road to knowledge, instead of being plunged into a morass of inexact and untrustworthy common names, however poetic. As a matter of fact there is as much poetry and folk-lore in the scientific names as in the common ones. Consider Campanula, Phlox, Asplenium and Helianthemum. Are these less euphonious or poetic than such "common" names as Judge Daly's sunflower, Stewardson Brown's Indian turnip, or Brainerd's cat's foot? There is undoubtedly much literary value in the common names of plants, but the same can not be claimed for the "English" or vernacular names with which we have been deluged of late. A common name is a name that is in common use for the plant in some part of the world and therefore entitled to consideration, but an "English" name is too often merely a poor translation of the scientific name and therefore better left in the original. Common names or, if you please, vernacular names, are still being coined—Christmas fern, foam flower, boulder fern, Darwin tulip, and obedient plant are good illustrations—but who expects such "English" names as repand-leaved erysimum, Hooker's musinon, Gregg's haploesthes, and tall flat-topped white aster to ever become common? In the opinion of many good observers the declining popularity of botany as a high-school study is due in large measure to the efforts of those well-intentioned but misguided popularizers of plant study who either by assertion or implication give to the scientific study of plants a reputation for difficulty which it does not deserve.

It is well to reflect, therefore, that common names can not be made by fiat. If a plant has a common name, we may well use it in the region where the name is common and therefore understood, but to imagine that there is any special sanctity in the common names as such and to insist upon their use on all occasions is as absurd as for the scientist to use technical terms in speaking of familiar species. In all cases where exactness is necessary, even well-known common names will not serve, for often a single plant will have several names or a single common name may be applied to several plants. In spite of the conspicuous differences that still exist between the adherents of the "American Code" and those who advocate the "Vienna Rules," the scientific names are still the safest to go by and all botanists would do well to insist upon their use. The sooner the general public discovers that even technical botany is still "the amiable science" the better it will be for all concerned.

Willard N. Clute

Joliet, Ill.

LACEPÈDE OR LACEPEDE

In going over "The Genera of Fishes" recently published by Dr David Starr Jordan, assisted by Barton Warren Evermann, I discover that these authors accept and adopt the view expressed by Sherborne in his "Index Animalium," p. lvii, where, under the head of "Additions and Corrections," Sherborne says:

> A letter dated 1831 is signed "b.g.é cte de lacepède." This spelling and accentuation should be adhered to.

The writer is very much inclined to think that both Sherborne and the learned authors of the recent paper on "The Genera of Fishes" err in accepting the accentuation of the name of the great Frenchman found attached to a scrap of paper bearing his name, which was evidently written in haste. "One swallow does not make a spring," and one hurriedly written autograph with the omission of the acute accent over the first "e" in the word does not prove that this was the correct way of writing the name. The writer of these lines is called upon every month to attach his signature hundreds of times to vouchers and other documents. He ordinarily puts a period after his initials, W and J; but only yesterday, having signed some two hundred vouchers, he observed that in the haste of doing so he had in a number of cases omitted the period after his initials. Personal observation shows him that just so it is not an infrequent thing for French gentlemen in hurried writing to c cent.

In the judgment of the writer of these lines the existence of one letter in which the French ichthyologist signed himself "lacepède" should not avail against the fact that in all his published writings the other method of accentuation prevails, that all biographies, encyclopædias, and dictionaries, in which the name occurs, give it as "Lacépède." If he were the only person who had borne the name there might be some weight attached to the signature, which Sherborne has turned up; but there were and are others in France who bear the name, and any one who takes the trouble to consult a French dictionary or encyclopædia of biography will find that invariably the name is and has been spelled "Lacépède." The name is so spelled in Buffon, who was the friend and contemporary of Lacépède, and I think it seems "rather late in the day" to change the universally accepted spelling of the name of the well-known naturalist on the strength of the L. S. discovered by Sherborne.

To be consistent, if the acute accent is omitted on the first "e," the capitals should also cease to be employed, not only in the family, but also the Christian names of Lacépède, for in the autograph which Sherborne quotes the name is written throughout without capitals. After carefully weighing the matter the writer is of the opinion that Buffon, the authors of the "Dictionnaire Universelle," and the thousand or more Frenchmen engaged in scientific research, who have for over a century written the name "Lacépède" are more likely to know what is correct than the author of the "Index Mammalium," who, having unearthed this L. S., has on the strength of it proceded in this particular to overthrow the usage of more than a century, and the usage of those who were the friends and acquaintances of Lacépède himself.

W. J. Holland

Pittsburgh, Pa.,
October 17, 1917

FORBES WINSLOW MEMORIAL HOSPITAL

To the Editor of Science: The British Ministry of Pensions has recognized and authorized for trial psychical treatment for soldiers suffering from shell-shock and nervous breakdown. It can not be too widely known that this is exactly the treatment practised at the British Hospital, 72 Camden Road, London, N. W. 1, England, for over a quarter of a century. The hospital has given effective and permanent relief gratuitously to thousands of men, women and children. The war has obviously increased the number of cases suffering from shell-shock and nervous breakdown to a marked extent, and the hospital is at present appealing for additional funds to cope with the position, and also with the object of sending patients into the country, so necessary for their speedy recovery.

Will our American friends help us? Donations, however small, will be greatly appreciated and may be sent to me or the Secretary, Mr. F. J. Lee-Smith, 72 Camden Road, London, N. W. 1, England.

MARGARET FORBES WINSLOW

QUOTATIONS

INCREASED RANK AND MORE AUTHORITY FOR MEDICAL OFFICERS

As most of our readers are aware, an amendment was introduced into Congress at the recent session which, if it had been adopted, would have given the medical officers in the Army the same rank that prevails in the Medical Corps of the Navy. Specifically the amendment provided that there should be twenty-five one-hundredths of 1 per cent. of major-generals, the same proportion of brigadier-generals, 4 per cent. of colonels, 8 per cent of lieutenant-colonels, 23.5 per cent. of majors, 32 per cent. of captains, and 32 per cent. of lieutenants, *this to apply to both the regular and the reserve corps men.* Thus, if there are 10,000 medical officers in active service, there might be 25 major-generals, 25 brigadier-generals, 400 colonels, 800 lieutenant-colonels, 2,350 majors, 3,200 captains and 3,200 first lieutenants. This amendment lapsed without action by the ending of the session. The substance of the amendment, however, will be incorporated in a bill which will be introduced in both the Senate and the House at the coming session of Congress.

Medical officers must be equal in rank and authority with line officers if they are adequately to carry out the duties for which they will be held responsible. This fact has been emphasized by the experience of our allies in the present war, as well as by our own experience in the past. Our allies admit that in the beginning the medical officer did not have the rank, and consequently the authority, he should have had and that, for this reason, there have been grievous consequences. Among these was the disastrous experience of the British Army in the Mesopotamian campaign as a result of the failure of the medical service. The report of this tragedy, made by a board of nonmedical men, showed that lack of authority of the medical officers was an important factor. The medical officers were practically ignored. They were not advised as to the character of the expedition that was being undertaken, and as a consequence, they were unprepared for what happened. When later a medical officer made urgent representations in regard to the actual conditions obtaining, which in his opinion needed prompt action, he was threatened with arrest and removal from his post. When the actual results came the blame was thrown on the medical department, of which this medical officer was a member. The medical officers were censured because they had not protested more vigorously. We had a similar experience in 1898 when our medical officers were criticized for insanitary conditions at Chickamauga and elsewhere, although there was plenty of evidence to show that they had protested against these conditions to line officers. The whole sad story is told in detail in the Dodge report. There, also, will be found testimony that line officers treated with contempt the recommendations and protests made by medical officers. The medical officer is without influence simply because his shoulder straps indicate lower rank than that of the line officer with whom he is associated. Some may sneer, but the fact remains that it is rank that counts in both the Army and the Navy.

Of course rank brings with it increased pay. This, however, is immaterial. At the same time, it should not be forgotten that most of the physicians now in the Medical Reserve Corps have not only left the comforts of their homes, but also have given up practises which in the majority of instances yielded far more income than the pay they would receive as medical officers of the Army even if they had conferred on them the highest rank that the proposed law would provide. Among these medical reserve officers are many of the most prominent men in our profession, including the leading men in the specialties, as well as our best surgeons and internists.

When the war broke out there were less than 450 medical officers in the regular Army Medical Corps. To-day there are commissioned, including officers of the regular Army, the National Guard and the Medical Reserve Corps, at least 17,000 physicians. Less than 1,000 are in the regular Army Medical Corps. Under the present law these regular Medical Corps officers are entitled to the grades of lieutenant-colonel and colonel; and in the case of the surgeon-general, to that of brigadier-general;[1] the highest rank that can be conferred on any one of the other 16,000—that is, on any reserve medical officer—is that of major.

May we remind our readers that the men in active service will be prevented by the regulations from using their influence in this matter, and that the duty of pushing this measure rests on those who stay at home? Every physician has representing him in Congress one man in the House of Representatives and another in the Senate. If every physician will let his representatives know that this proposed measure should become a law, and if in addition he will enlighten his neighbors in regard to the matter, an effective public opinion will be created. The time is opportune; congressmen are at their homes. Write or speak to your representatives now; get your neighbors to do likewise—not for the good of the medical profession, but for the good of the service.—*The Journal of the American Medical Association.*

SCIENTIFIC BOOKS

The Biology of Twins. By HORATIO HACKETT NEWMAN, Associate Professor of Zoology, and Dean in the Colleges of Science, University of Chicago. University of Chicago Press, 1917. Pp. 1–186. 55 figures in the text.

Polyembryony, or the production of more than one individual from a single fertilized egg, although a phenomenon occurring constantly in some groups of animals, and occasionally in others, including man, is as yet unmentioned in our text-books of general zoology, where the impression is given, or the statement even definitely made, that, except as the result of experiment, a single zygote, resulting from a normal fertilization, invariably results in the formation of a single individual.

That in the Texan armadillo a single egg always produces four individuals, and that a much more numerous progeny results from a single egg in certain of the gall-wasps (*Copidosoma*), are facts that are now forcibly brought to the attention of zoologists through the long and arduous labors of the two associates, H. H. Newman and J. W. Patterson.

While the original papers are necessary for one seeking the details, the essential points obtained by these and other investigators to date have been placed in a single small volume where, appearing in a not too technical dress, they are readily and conveniently available, not to zoologists alone, but to the thinking public in general.

The work is based upon the Texan armadillo (*Dasypus novemcinctum*), which produces four young at a birth, all of the same sex. After an introduction and a preliminary chapter, setting forth what is commonly known concerning twins in general, mainly human, and their probable relation to double monsters, there follows in Chapter II. an almost complete sketch of the development of the nine-banded armadillo. This sketch includes "the whole range of stages from ovogenesis to birth, with but one gap which, it is hoped, the near future will see filled in." This gap is that of the early cleavage stages, but as a partial substitute for these Newman refers to his paper of

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[1] Surgeon-General Gorgas has the rank of major-general by special act of Congress.

June, 1913 (*Biol. Bull.*), in which he records his observations on certain non-fertilized eggs, in which cleavage advanced parthenogenetically as far as the eight-cell stage, apparently in normal manner. In this chapter the gastrulation, the germ-layer inversion, and the formation of first two and then four embryos from the embryonic area, are given in order, followed by the subsequent separation of the four distinct embryos, each with its own amnion and placenta. Corresponding to their origin, two secondary embryos from the two primary ones, the four are distinctly paired, the two of each pair revealing a more complete identity than does either one when compared with a member of the other pair, and this relationship in certain extra-embryonal features, such as the approximation of the placentas of each pair, is shown in anatomical relations up to birth.

The condition in other species and genera of armadillo is presented in Chapter III., which shows that the number of young varies from *eight* (occasionally 7–12), polyembryonic ones in *Dasypus hybridus*, to *Euphractus villosus*, which is not polyembryonic, but produces fraternal twins from two separate eggs, or, occasionally, bears only a single young. The facts for this chapter are furnished largely by the work of Fernandez of the Museo Nacional at La Plata (Argentina), who has made special studies on the armadillos of South America, and whose first account of the polyembryony of *Daypus hybridus* appeared in 1900 (*Morph. Jahrb.*) almost simultaneously with the first paper of Newman and Patterson on the same phenomenon in *D. novemcinctus* (*Biol. Bull*).

Chapter IV., although short, has a special interest since in it the author discusses causes of polyembryonic development, thereby bringing in something of the many theories that have been brought forward to account for human twins, at least those of the *duplicate* or monochorial type. The author considers the phenomenon one of fission, "if by fission we mean merely the physiological isolation of several secondary points in a single embryonic vesicle, and the consequent acquisition by these points of independence in growth and development" (p. 93). He assumes a considerable amount of differentiation to have occurred before these points become isolated, "so that genetic factors are unequally distributed in the various regions which give rise to the new apical points," and thus if two embryos are developed from closely adjacent territory they are likely to be more nearly alike than those which are a greater distance apart on the blastoderm. This accounts for the phenomenon, substantiated by hundreds of observations, that the closely adjacent twins of a pair, where the placentas are nearly in contact, are closer duplicates that are individuals taken from the two pairs.

Chapter V. considers the phenomenon of the free-martin in cattle, or the occurrence of a normal male twin with an imperfect twin, variously considered an hermaphrodite, an imperfect female, or an imperfect male. The author was fortunately able to avail himself of the work of Lillie and his pupil Miss Chapin, previous to its publication (*J. Exp. Zool.*, July, 1917) and thus presents this work as revealed by the latest investigation. This shows conclusively that the free-martin is a sterile female, with abortive gonads, and with certain of the secondary characters of the male due to the influence of male hormones from the associated male, obtained from the blood circulating in the common placenta. This is a totally different phenomenon from that presented by armadillos, as the twins are here of the fraternal type (*dizygotic*), and in the latter true duplicates (*monozygotic*).

The two final chapters, VI. and VII., show the various contributions to general biological problems afforded by the study of twins, especially in the case of variation and heredity, and here the work of the author and his associate on armadillos, where the scales of the carapace are used to show the amount of identity, links up extremely well with that of Wilder on human twins, who has employed in a similar way the conformation of the friction-ridges of the palms and soles. Indeed, there is probably more than a general correspondence in method between these two independent series of investigations, since it is altogether likely that the human friction-ridges are formed of rows of integumental scales, and that they are thus the same sort of organ as are the bands of the armadillo carapace, which Newman finds so convenient for the comparison of individuals.

The last and longest chapter, Chapter VII., gives a detailed study of the results of both lines of investigation, and presents, with numerous illustrations the strange correspondences in detail in the external characters of monozygotic twins, whether found in the carapace of the armadillo, or in the palm and sole ridges of man. These two series of studies serve to strengthen each other, and are shown to be essentially similar phenomena, of great biological significance. In the facility with which embryonic material of every stage may be obtained the armadillo has a decided advantage over man as a *Versuchstier,* although in the enormous amount of detail presented by human palms and soles, and the readiness with which they may be compared in the form of prints, there are certain distinct advantages in the study of man. If once the essential identity of the phenomenon of polyembryony in *Dasypus* and *Homo* be generally recognized, those parts of the history of human duplicate twins (and perhaps, of double monsters as well) which are beyond our power to observe directly, may be satisfactorily supplied through the study of the corresponding stages in the armadillo; while the correspondences in the friction-skin configuration of human monozygotic twins may be added to those observed in the carapace of the armadillo to show the amount of power possessed by the germplasm, or some other element or elements of the egg, to determine the details of the adult soma.

H. H. W.

Economic Geology. By HEINRICH RIES, A.M., Ph.D. Fourth edition. John Wiley and Sons.

The appearance of the fourth edition of this excellent and standard book on the subject, in the midst of a year of battle largely as to supplies of war materials, deserves attention, since the change of publishers has been marked by thorough rewriting and extensive additions.

The statistics and references are brought down to 1914–15, showing the first effect of the war, but not the rebound. Not only are there 25 per cent. more illustrations, but many of the less legible ones are redrawn and greatly improved. Compare, for instance, those on pages 529 and 545 of the new with the corresponding figures on pages 367 and 378 of the old. A large number of half tones taken by the author show that the descriptions of the various ore deposits are not mere compilations. This is perhaps the main use of some of them, for undated views of a mine do not show what now is. Would it not be well if in scientific works the date of views were always given?

The main improvement of the book, however, is that it now includes descriptions, in but slightly smaller type, of the chief rival ore deposits in other countries, and thus makes possible a much more comprehensive handling of the great question of ore deposits. For instance, the Swedish deposits of Kiruna receive first-hand treatment, and there is a plate of a section of Luxembourg iron ores. While the treatment is and must be brief, there are always one or two recent references to start one on further search. The summaries of different views as to the origin of ores, for instance, Cuban ores, though brief, are well done. While the author does not hesitate at times to express his own views, yet he gives rival views. The account, for instance, of the oölitic iron-ore deposits could hardly be improved for so brief a statement

While of course the publications of the United States Geological Survey have been largely used, they are by no means the exclusive source, and the various publications of the mining engineering societies have been also duly consulted.

The table of geographic and geologic distribution of coal in the United States is a new and valuable feature, and the general subject of coal receives very satisfactory treatment. If the source of the analyses of coal on pages 8 and 9 is given it has been overlooked by the reviewer.

The treatment of copper has been brought to date by reference to the Nonesuch Lode.

But in the footnote at the bottom of page 609, by the term "Lake ore" the writer really means "Lake copper" and his statement that "the term has now lost its original meaning" is hardly justifiable, since in the first place for "ore" one should read "copper," and in the second place, that western copper should have been almost fraudulently sold as Lake copper does not signify that the term has lost its meaning; otherwise there would have been no object in the trick. In fact the difference in selling price between Lake copper and electrolytic copper has been unusually great at times during the last three years.

Although of course, the book is primarily a text-book, yet the summaries of different theories as to ore deposits (see, for instance, the discussion of Mississipi zinc), often largely based upon original studies, are so valuable that no one interested in its field can afford to be without the book.

Alfred C. Lane

Tufts College

SPECIAL ARTICLES

EXPERIMENTS WITH A FOCAULT PENDULUM

In the issue of Science for March 16, last Dr. Carl Barus, under the above title, described certain measurements of the rotation of the plane of oscillation of a Focault pendulum. The present note gives, for the same determination, another method that is simple, direct and of fair accuracy.

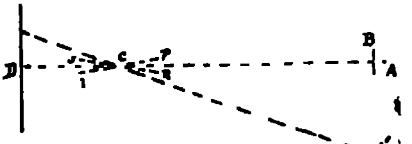

Fig. 1.

If in Fig. 1 the point A represent an arc lamp that, through the slit B, illuminates a portion of the scale D; and if PQ represent the plane of vibration of a Focault pendulum at a given time, it is evident that the diffraction pattern of the wire will travel up and down the scale as the pendulum oscillates. Further, as the plane of the vibration rotates about the center at C, the amplitude of the motion of the shadow on D will decrease, and will become zero at the instant when the oscillation plane includes the line DCA. This amplitude of the shadow's motion will increase again as the plane of vibration continues its rotation towards the position BS. If the position on the scale of one edge of the central band be taken at each successive elongation of the pendulum; and if these readings be plotted against the time (in terms of the period of the pendulum) two approximately

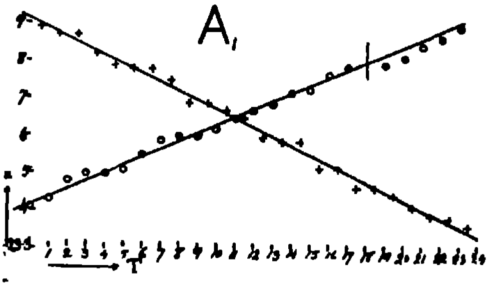

Fig. 2a.

straight lines will be obtained. The coordinates of the intersection of these lines will give (1) the point on the scale where it is cut by the vertical plane that includes the line AC, and (2) the time (in terms of the period of the pendulum) of the coincidence of the plane of vibration with the vertical plane defined in (1) (see Fig. 2, a and b).

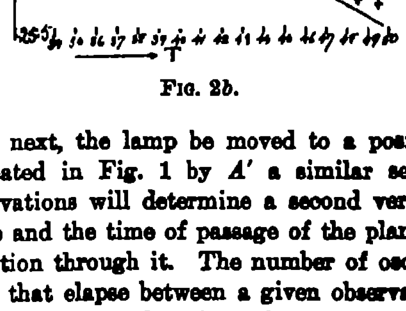

Fig. 2b.

If, next, the lamp be moved to a position indicated in Fig. 1 by A' a similar set of observations will determine a second vertical plane and the time of passage of the plane of vibration through it. The number of oscillations that elapse between a given observation of the first set and a given observation of the second set is determined by starting a stop-watch as the first reading of the first set taken, and stopping it at the first observation of the second set. This time divided by the known period of the pendulum will fix the number of oscillations from the first of one set to the first of the other, *i. e.*, it will give the oscillation number of the first elongation of the second set, the initial elongation of the first set being taken as zero. Thus knowing the distance of the scale D from the center of oscillation C, and the intersections of the two vertical planes at D, we get the angle between them; and from this and the time interval the angular velocity of the rotation of the plane of vibration follows at once.

The first attempts to use this method were made with the slit about two meters from the center at C, and the scale six meters away. The observations were made on the first diffraction minimum to one side of the pattern, but the decay of the amplitude of vibration introduced here an undeterminable correction which was too large to be neglected. The final procedure was to put the arc about six meters from the center and to bring the scale to two meters. Readings were then made of the edge of the central dark shadow—the bright line in the middle of the shadow being too faint for quick reading. Under these circumstances the variation of the width of the central shadow, even in its extreme positions, was negligible.

The Apparatus.—A turned leaden sphere of mass 4.8 kilograms was suspended from a roof joist of the laboratory by a long steel piano wire 0.39 mm. diam. Attached to the wire, so that its shadow would cross the scale D at each oscillation, was a small ball of wax. As the screen was about a meter above the floor and the arc about 20 centimeters, this shadow was at its highest point at one maximum elongation of the bob and at its lowest at the other. By noting the motion of the shadow of the wax ball at the ends of its path one could detect any tendency to elliptical motion of the bob. The prevention of such motion is, of course, one of the difficulties in securing good results.

The period of the pendulum was 7.50 secs.

To start the oscillation the bob was drawn back 40 or 50 cm. from its equilibrium position and held there by a belt of thread that passed about its equator and through a small horizontal pulley, which latter was fastened to a standard by the thread which was to be burned in releasing the pendulum (see Fig. 3). The object of the pulley was to prevent torsional strain in the wire, but as the restoring couple was so small for the wire in question it was found best to place a mark on the sphere after it had been hanging at rest for some time, and to adjust the ball in its belt so that the mark was at its original azimuth. Next, to damp out side motion of the bob the following device proved efficient; a flat disc of cork (about 2 cm. diam.) was fixed centrally on the inside of a light tin dish (top of a coffee can, 11 cm. diam. See Fig. 3) and this was floated on cylinder oil in a larger vessel that was carried on a table that could be racked up and down (the front of a projection lantern). This system was placed centrally under the bob in its deflected condition, and was raised until the cork just touched the sphere. The slight friction between them caused the dish to move with the bob, so that the oil quickly damped the resid-

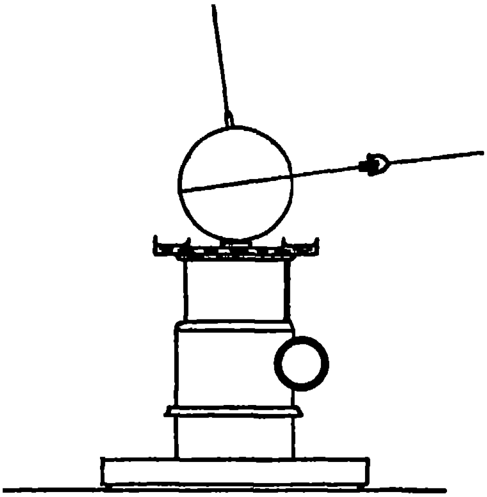

FIG. 3.

ual motion. When all was perfectly still—as indicated by the absence of movement of the shadow *D*—the damping system was lowered away and the thread behind the pulley quickly burned through. If the bob were left hanging after the removal of the damping system, air currents and the tremors of the building soon set it swinging again—for these observations were made while other operations were being carried on in the same building. After releasing the bob the position of the arc lamp was adjusted so that the amplitude of the shadow's motion was decreasing and was about 5 mm. on the scale. Readings were then made of successive elongations until the plane of the pendulum's motion had passed completely through the plane fixed by the slit and the vertical through the point *C*. Readings were always begun with the outward swing of the pendulum so that no ambiguity resulted from the recording only the millimeters and tenths after the first. The record for the first few points of experiment A (below) for instance was :

23.42 cm.
.89
.47
.87
etc.

Blanks (when the arc sputtered or the eye did not catch the turning point) were indicated, both in the record and on the graph, by strokes.

The determination of the point on the floor directly beneath the center of suspension was effected as follows: A metal plate with a peep-hole (1 mm. diam.) was held in the laboratory stand so that the plumb-bob, hung through the hole, fell just over the edge of one of the feet of the stand, about a meter below. A straight-edge placed on the floor against this foot, when observed through the peep-hole, defined a vertical plane. The bob was then set swinging through an arc of amplitude equal to its own radius and the position of the straight-edge was adjusted until at extreme elongations the sphere appeared tangent to the straight-edge on opposite sides successively. A line drawn along the straight-edge must contain a point vertically under the center of suspension. In this same manner two other lines, each at about 60° to the first, were determined, and the center of the resulting triangle (about 1 mm. altitude) was taken as the point required.

Trouble was found at first at the suspension point itself, but this was finally overcome by boring a 5-mm. hole half way through a stout piece of brass and finishing it through with a half millimeter drill. The wire was then inserted, the larger hole being in the lower side of the bar. The hole was then filled with solder, sufficient being used to leave the surface slightly convex. This excess was scraped away with a knife, leaving a plane surface from which the pendulum could swing. The bar was then clamped into place against the roof joist.

The details of a set of five consecutive readings taken on the fifteenth of May, 1917, are as follows:

Latitude of Kingston 44° 13′.

Period of Pendulum $T = 7.50$ sec.

Distance to scale from center of oscillation

Coordinates of intersections of lines on graph t_1, t_2, x_1, x_2

Angular velocity of plane of vibration

$$\omega = \frac{x_2 - x_1}{(t_2 - t_1)T200}$$

Experiment	t_1	t_2	x_1 (cm.)	x_2 (cm.)	ω (Radians per Second)
A	10.9 T	39.3 T	23.65	25.81	5.07×10^{-5}
B	19.5 T	64.5 T	21.58	24.92	4.95
C	10.5 T	44.1 T	20.90	23.39	4.95
D	13.3 T	53.9 T	20.94	24.04	5.09
E	14.4 T	48.6 T	22.04	25.30	5.18
Mean					5.05×10^{-5}
Calculated value at Kingston....					5.08×10^{-5}

Of these the experiment of shortest duration was *A*, which included 28.4 periods or about 3½ minutes; the longest was *B*, of 45 periods, or about 5½ minutes.

Will C. Baker

Physical Laboratory,
Queen's University,
Kingston, Ont.,
May 18, 1917

THE PHILADELPHIA MEETING OF THE NATIONAL ACADEMY OF SCIENCES

The autumn meeting will be held at Philadelphia, November 20 and 21, in the engineering building of the University of Pennsylvania. On Tuesday evening a reception for the members of the academy and invited guests will be given by Provost and Mrs. Smith at the University Museum at 9 o'clock. The academy dinner will take place at the Bellevue-Stratford on Wednesday evening at 7.30 o'clock.

The scientific sessions are as follows:

Tuesday, November 20, 10.30–12.30

The wheat problem of the United States, Erwin F. Smith, Bureau of Plant Industry, U. S. Department of Agriculture.

The modern systematist, Liberty H. Bailey, Cornell University.

A criticism of the evidence for the mutation theory of De Vries from the behavior of *Œnothera* in crosses and in selfed lines (by invitation), Bradley M. Davis, University of Pennsylvania.

The chemical mechanism of regeneration, Jacques Loeb, Rockefeller Institute.

A comparison of growth changes in the nervous system of the rat with the corresponding changes in man, Henry H. Donaldson, the Wistar Institute.

Hereditary tendency to form nerve tumors, Charles B. Davenport, Station for Experimental Evolution, Carnegie Institution.

Food hormones or vitamines in some animal tissues (to be presented by L. B. Mendel), Lafayette B. Mendel and Thomas B. Osborne, Yale University.

Tuesday Afternoon, 2.00–4.00

The atomic weight of boron, Edgar F. Smith and Walter K. VanHaagen, University of Pennsylvania.

The effect of intravenous injection of magnesium sulphate upon tetanus—with a lantern slide demonstration by J. Auer (by invitation), Samuel J. Meltzer and John Auer.

Chemotherapy of spirochetal infections, for Drs. Jacobs and Brown, Simon Flexner, Rockefeller Institute.

Possible action of the sex-determining mechanism (by invitation), Clarence E. McClung, University of Pennsylvania.

The cause of mosaics and gynandromorphs in *Drosophila*, Thomas H. Morgan, Columbia University.

Spectrum analysis by different persistence of vision (by invitation), Herbert E. Ives, Physical Laboratory, The United Gas Improvement Company.

Wednesday, November 21, 9.30–10.30

The atmosphere and terrestrial radiation, Charles G. Abbot, Smithsonian Astrophysical Observatory.

Geometric aspects of the theory of heat, Edward Kasner, Columbia University.

Invariants which are functions of parameters of the transformation (by invitation), Oliver E. Glenn, University of Pennsylvania.

The validity of the thermoelectric equation $P = T(dv/dT)$, Edwin H. Hall, Harvard University.

A thermoelectric diagram on the P. V. plane, Edwin H. Hall, Harvard University.

The Astrapotheria of the Patagonian Miocene, William B. Scott, Princeton University.

Evolution of the Titanotheres: Final conclusions, Henry F. Osborn, American Museum of Natural History.

Study of the motions of forty-eight double stars (by invitation), Eric Doolittle, University of Pennsylvania.

A determination of the solar motion and of stream motion based on absolute magnitudes (read by Professor Hale), Gustaf Strömberg, Mt. Wilson Solar Observatory, Carnegie Institution (introduced by Walter S. Adams).

Wednesday Afternoon, 2.00–4.00

The coral reefs of Tutuila, Samoa, Alfred G. Mayer, Marine Laboratory, Carnegie Institution.

The subsidence of volcanic islands, William M. Davis, Harvard University.

A duty of the International Association of Academies, William M. Davis, Harvard University.

The work of the Anthropology Committee of the National Research Council, William H. Holmes, U. S. National Museum.

The work of the Psychological Committee of the National Research Council, Edward L. Thorndike, Columbia University.

The work of the National Research Council, George E. Hale, Mt. Wilson Solar Observatory, Carnegie Institution.

Biographical memoir of James D. Dana (read by title), Louis V. Pirsson, Yale University.

Biographical memoir of Cleveland Abbe (read by title), William J. Humphreys, U. S. Weather Bureau (introduced by A. L. Day).

SCIENCE

FRIDAY, NOVEMBER 23, 1917

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ELECTROMERISM, A CASE OF CHEMICAL ISOMERISM RESULTING FROM A DIFFERENCE IN DISTRIBUTION OF VALENCE ELECTRONS[1]

RECENT advances in our knowledge of the structure of matter have made it possible for an organic chemist to address a group of non-organic chemists and of physicists upon this subject without apologizing. During a period which is not far behind us in the past, not only the validity, but, possibly, even the utility of employing structure conceptions requiring atoms and their arrangements was brought into question; so that the organic chemist, who has maintained an abiding faith in atoms and a confidence in his ability to decipher something of their arrangements in molecules, became aware of an indulgent smile whenever he broached this subject except in the company of his own confrères.

With this inheritance, it is natural to expect that the organic chemist would welcome any discoveries which make our conception of atoms and of the mechanism by which atoms combine to form molecules more concrete; and that he would be among the first to seek to apply these concepts to special problems in his own field.

With a feeling of keen satisfaction, therefore, we learn through the work of Bragg that, in a diamond crystal, each carbon atom is surrounded by four other carbon atoms placed equidistant from it. These atoms are grouped around the central carbon atom as the four corners of a regular tetrahedron are arranged around its center. Thus, the tetravalent character of the carbon atom manifests itself clearly. Furthermore, when a model of a diamond crystal is examined, it is discovered that the atoms appear to arrange themselves in rings of six. These relationships suggest at once well known fundamental theories of the organic chemist.

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[1] An address prepared for the symposium on the "Structure of Matter," held at the meeting of the American Association for the Advancement of Science in New York City, December, 1916.

Through the writings of J. J. Thomson,[2] Stark,[3] Abegg[4] and many others, the conviction has been reached, that the forces which hold the atoms together, commonly called chemical affinity, are chiefly, if not wholly, electrical in character. The impetus to this interpretation has come from the discovery that electricity itself possesses an atomic structure, and that our material atoms appear to be composed of units of positive and negative electrical atoms nicely balanced in the neutral atom. As Carl Barus says:[5]

> Not only has energy possessed herself of inertia, but with ever stronger insistence she is usurping the atomic structure once believed to be among the very insignia of matter. Contemporaneously matter, itself, the massive, the indestructible, endowed by Lavoisier with a sort of physical immortality, recedes ever more into the background among the shades of velocity and acceleration.

Electrochemical theories have not been lacking in the development of chemistry. For many years the electrochemical theory of Berzelius was a guide in the interpretation of chemical phenomena. There is, perhaps, no greater tragedy recorded in the annals of science during the past one hundred years than that which overtook Berzelius at the close of his active career as leader of chemical thought. We of to-day know best why this theory failed, and why. we are now busily engaged in formulating a new electrochemical theory, as well as a new electrophysical theory. In fact, J. Stark in his recent work, "Die Elektrizität im chemischen Atom," gives a eulogy of Berzelius, and points out the many striking qualitative resemblances which the theory of Berzelius bears to his own.

The special purpose of my remarks today precludes any detailed discussion of the various theories concerning the structure of the atom. This phase of the subject has already been presented in the morning meeting of this symposium. It may be said that all theories agree upon a positive core or nucleus associated with negative electrons, the atoms of negative electricity. Thomson presents hypotheses concerning the possible arrangements within the atom, while Stark limits his treatment chiefly to the surface layer. The surface layer, he says, contains an excess of positive electricity. In the neutral atom one or more electrons, called valence electrons, are held close to the surface of the atom by this positive charge. Compounds are formed, when the lines of force from one or more of these valence electrons reach out and end on the positive areas of other atoms. In the case of strongly polar compounds, an electron is almost wholly drawn over to the atom which it then holds combined.

Lewis[6] classifies compounds into polar and non-polar, but in a footnote remarks:

> It must not be assumed that any one compound corresponds wholly, and at all times, to any one type.

He distinguishes between valence number and polar number. Valence number he defines as the number of positions, or regions, or points (bond termini) on the atom at which attachment to corresponding points on other atoms may occur. Polar number is the number of negative electrons which an atom has lost (in an algebraic sense).

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[2] J. J. Thomson, *Phil. Mag.*, March, 1904, 27, 757 (1914), etc.

[3] J. Stark, "Die Elektrizitut im Chemischen Atom," Leipzig, 1915.

[4] Abegg, *Z. Anorg. Chem.*, 39, 330 (1904); 50, 309 (1906).

[5] SCIENCE, N. S., Vol. XL., 727, 1914.

[6] G. N. Lewis, *J. Am. Chem. Soc.*, 38, 762 (1916).

> The evidence of, perhaps, indeed, the cause of the mobility of polar compounds is the freedom of one especially important atom, the atom of electricity, or the electron, to move from one position to another.

From a study of the reactions of chemical compounds, and in particular of organic compounds, it seems doubtful whether the classification into polar and non-polar based upon physical values, such as the dielectric constants[7] of compounds in the gaseous state, is of any more significance than the terms electrolyte and nonelectrolyte were to the older supporters of the theory of Arrhenius. In time, it came to be known that it was no easy matter to draw the dividing line between these two classes, and that one class seemed to merge imperceptibly into the other. So, with polar and non-polar compounds, it seems theoretically probable that there is no perfectly non-polar compound, unless it be a molecule composed of two like univalent atoms, such as hydrogen;[8] and that other compounds are polar in varying degrees, depending upon the mutual attractions between valence electrons and the positive surfaces or cores of the atoms combined, and upon the distances to which these electrons, in forming such compounds, are deflected from their normal positions relative to the positive areas of the uncombined atoms themselves.

Even before the electron theory had been proposed, an application of the theory of ion formation and charges upon ions led to the recognition of polar characteristics in compounds not known to be ionogens.

In a study of chloroamines, RNHCl and R_2NCl, Seliwanow[9] observed that, during hydrolyses, the chlorine in these compounds was replaced by hydrogen; and that they interacted with hydrogen iodide with the liberation of two equivalents of iodine for each equivalent of combined chlorine,

$$R_2NCl + 2\ HI = R_2NH + HCl + I_2.$$

Usually, during hydrolysis, combined chlorine in organic compounds is exchanged for hydroxyl and has no tendency to liberate iodine from hydriodic acid. Seliwanow ascribed this peculiar behavior of the chlorine atom in chloroamines to the fact that, *even in combination*, it existed as *"hypochlorous chlorine."* He pointed out that the chlorine atoms in nitrogen trichloride, NCl_3, also showed the same peculiar behavior.

In 1901, Noyes and Lyon,[10] in performing Hofmann's well-known lecture experiment for demonstrating the composition of ammonia, observed that, under certain favorable conditions, the amount of nitrogen liberated as free nitrogen was about one sixth, instead of one third, the volume of the chlorine used. They explained this reaction by the following equation:

---

[7] Stark ("Die Elektrizität im Chemischen Atom," p. 39) says: "Between the properties 'dielectric' and 'conducting' there is a connection. In a dielectric medium, since there are positive and negative 'Quanten' bound to one another, it follows that the medium may become conducting when, through proper application of energy from without, the 'Quanten' pairs become partially dissociated, or ionized; that is, into freely moving positive and negative 'Quanten.' Conversely, the ions of a conducting medium by mutual union to form 'Quanten' pairs may make the medium dielectric; and in general a material medium is at the same time dielectric and conducting, so that by assigning a dielectric constant and a specific conductivity, the medium is characterized for a finite electric field and a finite electrical current."

[8] Bohr concludes that the hydrogen molecule consists of two hydrogen nuclei (at a distance apart of 0.60×10^{-8} cm.), and two electrons which revolve in an orbit in a plane perpendicular to the line joining the nuclei.

[9] Seliwanow, *Ber.*, 25, 3612 (1892).

[10] W. A. Noyes, A. C. Lyon, *J. Am. Chem. Soc.*, 23, 460 (1901).

$$12\,\mathrm{NH_3} + 6\,\mathrm{Cl_2} = \mathrm{N_2} + \mathrm{NCl_3} + 9\,\mathrm{NH_4Cl}$$

This observation led them to study the chemical properties of nitrogen trichloride. They found that each chlorine atom present in nitrogen trichloride was equivalent to two atoms of "available chlorine," or, as Seliwanow had put it, the chlorine is hypochlorous in character. Noyes and Lyon represented nitrogen trichloride as follows:

$$\mathrm{N}\begin{array}{l}-+\mathrm{Cl}\\-+\mathrm{Cl}\\-+\mathrm{Cl}\end{array}$$

and, to account for the reaction between ammonia and chlorine, assumed that ammonia may *ionize* in two ways,

$$\mathrm{N}\begin{array}{c}+\\+\\+\end{array} + 3\mathrm{H}^- \rightleftarrows \mathrm{NH_3} \rightleftarrows \mathrm{N} \equiv + 3\mathrm{H}^+$$

and, furthermore, that the chlorine molecule may ionize to give both positive and negative chlorine ions.

In the same number of the *Journal of the American Chemical Society*, Stieglitz[11] commented upon the work of Noyes and Lyon, and put forth arguments to show that this reaction,

$$\mathrm{H_2O} + \mathrm{Cl_2} \rightleftarrows \mathrm{HCl} + \mathrm{HOCl},$$

a reversible reaction, was, at the same time, an *ionic reaction*. In other words, hypochlorous acid may ionize in two ways, amphoterically,

$$\begin{array}{l}\mathrm{HOCl} \rightleftarrows \mathrm{H^+} + \mathrm{OCl^-}\\ \mathrm{HOCl} \rightleftarrows \mathrm{HO^-} + \mathrm{Cl^+}.\end{array}$$

The chlorine molecule, therefore, must yield negative chlorine ions, $\mathrm{Cl^-}$, and, also, positive chlorine ions, $\mathrm{Cl^+}$.

These deductions, expressed originally by Noyes and Lyon, as well as by Stieglitz, in terms of ion formation, have since been translated into the language of the electron theory of valence. Thus, the chlorine molecule may be represented electronically by the symbol, $\mathrm{Cl} - + \mathrm{Cl}$.

The striking difference in behavior of derivatives of positive chlorine and of negative chlorine may be illustrated by comparing the two compounds, nitrogen trichloride and phosphorus trichloride, which, by virtue of the family relationship of nitrogen and phosphorus in the periodic system, and the similarity in the formulas of the two chlorides, would be expected to resemble one another in chemical behavior about as closely as any two compounds could. At the same time, the illustration will serve to explain the significance of the statement made in an earlier part of this paper, viz., that the polar characteristics of compounds may be revealed by a study of their chemical interactions.

If the electronic formulas,

$$\mathrm{N}\begin{array}{l}-+\mathrm{Cl}\\-+\mathrm{Cl}\\-+\mathrm{Cl}\end{array} \qquad\qquad \mathrm{P}\begin{array}{l}+-\mathrm{Cl}\\+-\mathrm{Cl}\\+-\mathrm{Cl}\end{array}$$

are assigned to these two substances, we obtain formulas which, unlike those in general use, show why it is that the two compounds are most dissimilar in chemical deportment; why nitrogen trichloride, when hydrolyzed, gives ammonia and hypochlorous acid, while phosphorus trichloride yields phosphorus acid and hydrogen chloride; why the chlorine atom in nitrogen trichloride possesses oxidizing properties, while the chlorine in phosphorus trichloride does not. The oxidizing value of a positive chlorine atom corresponds to a gain of two negative electrons, if a negative chlorine ion is the final stage in the change.

$$\mathrm{Cl^+} \rightarrow \mathrm{Cl} \rightarrow \mathrm{Cl^-}.$$

Certain other halogen compounds have been found to show similar polar differences. Thus, Nef[12] observed that chlorocyanogen, upon hydrolysis, gave hydrogen chloride and cyanic acid, while iodocyanogen gave hypoiodous acid and prussic acid,

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[11] Stieglitz, *J. Am. Chem. Soc.*, 23, 797 (1901).

[12] Nef, *Ann.*, 308, 320 (1899); *ibid.*, 329 (1899).

$$\mathrm{Cl} -+ \mathrm{CN} + \mathrm{H} +- \mathrm{OH} = \mathrm{H} +- \mathrm{Cl} + \mathrm{HO} -+ \mathrm{CN},$$

$$\mathrm{I} +- \mathrm{CN} + \mathrm{H} +- \mathrm{OH} = \mathrm{HO} -+ \mathrm{I} + \mathrm{H} +- \mathrm{CN}.$$

Tetrabromomethane and tetraiodomethane, when hydrolyzed, give bromoform and iodoform, respectively:

$$\mathrm{Br_3C} -+ \mathrm{Br} + \overset{+}{\mathrm{H}}\mathrm{O}\overset{-}{\mathrm{H}} = \mathrm{Br_3C} -+ \mathrm{H} + \mathrm{HO} -+ \mathrm{Br},$$

$$\mathrm{I_3C} -+ \mathrm{I} + \overset{+}{\mathrm{H}}\mathrm{O}\overset{-}{\mathrm{H}} = \mathrm{I_3C} -+ \mathrm{H} + \mathrm{HO} -+ \mathrm{I}.$$

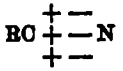
Iodine monochloride reacts as follows:

$$\mathrm{I} +- \mathrm{Cl} + \mathrm{H}^{+} - \mathrm{OH} = \mathrm{HO} -+ \mathrm{I} + \mathrm{H} +- \mathrm{Cl}.$$

In fact, there is no difficulty in finding among organic compounds countless cases in which the polarity manifests itself clearly during chemical changes. Thus, in the case of alkyl cyanides, RCN, it may be asked what indication there is in the formula itself to lead chemists to predict, unerringly, that the products of hydrolysis of such a compound are always ammonia and a carboxylic acid. Pure speculation would suggest that at least four different sets of products are possible:

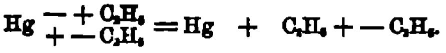
(*a*) $RC(OH)_3$ and NH_3;
(*b*) $ROH(OH)_2$ and NH_2OH;
(*c*) RCH_2OH and $NH(OH)_2$;
(*d*) RCH_3 and $N(OH)_3$.

But the substances expressed under (*a*) are the only ones ever realized. That this decision is not inherent in the formula is emphasized all too forcibly by the fact that these four sets of products are the very ones which beginning students offer to explain the hydrolysis of an alkyl cyanide. In terms of the electron conception valence, the explanation lies in the fact that the nitriles are polar compounds of the formula:



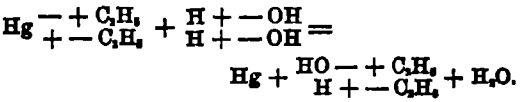
$$\mathrm{RC}\begin{matrix}+-\\+-\\+-\end{matrix}\mathrm{N}$$

In this connection, some recent experiments on mercury dialkyls carried out with Mr. Werner in our laboratory have led to the observation that, upon complete hydrolysis in the presence of acetic acid, the products formed are *metallic mercury*, an *alcohol*, and a *hydrocarbon*. At about 200°, mercury diethyl decomposes to give mercury and butane. This dissociation implies that the mercury atom in these dialkyls either possesses, or readily assumes, the condition of reduction which it has in the metallic state, viz., with an equal number of positive and negative "charges." This suggests, also, that the two ethyl groups may be one negative and the other positive:



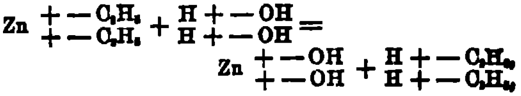
$$\mathrm{Hg}\begin{matrix}-+\mathrm{C_2H_5}\\+-\mathrm{C_2H_5}\end{matrix} = \mathrm{Hg} + \mathrm{C_2H_5} +- \mathrm{C_2H_5}.$$

When mercury diethyl is heated with acetic acid, further evidence in support of this inference is furnished; a quantitative yield of metallic mercury is found, and in addition, ethane and ethyl alcohol (or acetic ethyl ester). These changes may be expressed in terms of the electron conception of valence as follows:

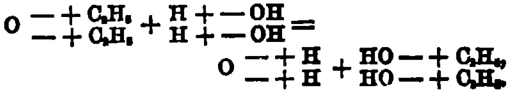


$$\mathrm{Hg}\begin{matrix}-+\mathrm{C_2H_5}\\+-\mathrm{C_2H_5}\end{matrix} + \begin{matrix}\mathrm{H}+-\mathrm{OH}\\\mathrm{H}+-\mathrm{OH}\end{matrix} = \mathrm{Hg} + \begin{matrix}\mathrm{HO}-+\mathrm{C_2H_5}\\\mathrm{H}+-\mathrm{C_2H_5}\end{matrix} + \mathrm{H_2O}.$$

If these reactions of mercury diethyl are compared with those of zinc alkyls and of oxygen alkyls, the significance of the statement that the polar characteristic of compounds becomes manifest during chemical changes will be apparent. Thus, zinc alkyls are hydrolyzed to give exclusively *zinc hydroxide* and a *hydrocarbon;* oxygen alkyls give exclusively *alcohols*.



$$\mathrm{Zn}\begin{matrix}+-\mathrm{C_2H_5}\\+-\mathrm{C_2H_5}\end{matrix} + \begin{matrix}\mathrm{H}+-\mathrm{OH}\\\mathrm{H}+-\mathrm{OH}\end{matrix} = \mathrm{Zn}\begin{matrix}+-\mathrm{OH}\\+-\mathrm{OH}\end{matrix} + \begin{matrix}\mathrm{H}+-\mathrm{C_2H_5}\\\mathrm{H}+-\mathrm{C_2H_5}\end{matrix},$$



$$\mathrm{O}\begin{matrix}-+\mathrm{C_2H_5}\\-+\mathrm{C_2H_5}\end{matrix} + \begin{matrix}\mathrm{H}+-\mathrm{OH}\\\mathrm{H}+-\mathrm{OH}\end{matrix} = \mathrm{O}\begin{matrix}-+\mathrm{H}\\-+\mathrm{H}\end{matrix} + \begin{matrix}\mathrm{HO}-+\mathrm{C_2H_5}\\\mathrm{HO}-+\mathrm{C_2H_5}\end{matrix}.$$

If, therefore, the atoms in compounds may function positively or negatively, in general a univalent atom, *A*, may be represented by two electronic symbols, *A* + and

$A-$; and an atom whose valence is n may function in $(n+1)$ ways electronically. Thus:

$$\mathrm{O}\,\substack{+\\+},\quad \mathrm{O}\,\substack{-\\+},\quad \mathrm{O}\,\substack{-\\-},$$

$$\mathrm{N}\,\substack{+\\+\\+},\quad \mathrm{N}\,\substack{+\\+\\-},\quad \mathrm{N}\,\substack{+\\-\\-},\quad \mathrm{N}\,\substack{-\\-\\-}.$$

A compound formed by the union of the univalent atoms, A and B, may be represented by two electronic formulas:

$$A+-B \text{ and } A-+B.$$

These two formulas represent isomers in a peculiar sense, quite unlike structural isomers. The difference lies solely in the distribution of valence electrons. Two or more compounds related in this manner have been called electronic isomers, or *electromers*.[13]

There is a certain resemblance between electromers and structure tautomers. While the transformation of one tautomer into another is accompanied by a wandering of an atom from one position in the molecule to a new position, the transformation of one electromer into another depends upon a more subtle change, viz., of electrons, or negative atoms of electricity, from one position to another within the molecule. Furthermore, it would be expected that, like tautomers, one electromer would be more stable than the other, and, in the majority of cases, that only one form might be capable of isolation, but that under certain favorable conditions, both electromers might be realized.

Moreover, between two electromers there might exist a condition of equilibrium similar to that which exists between tautomers and desmotrops, viz.,

$$A+-B \rightleftarrows A-+B.$$

Many cases requiring an assumption of such a relationship have been observed. One simple illustration will suffice. When benzene sulphonic acid is subjected to the action of superheated steam, it yields benzene, C_6H_6, and sulphuric acid. But if the same sample is heated with caustic alkalies, the products are phenol, C_6H_5OH, and sulphurous acid (or sulphites). Since benzene and phenole, as well as sulphurous acid and sulphuric acid, are related as oxidation-reduction products, the question arises what is the electronic formula of benzene sulphonic acid? To account for the substances formed in the two reactions, it must be assumed that two electronic formulas may be assigned to benzene sulphonic acid, and that the two substances represented by these formulas are in equilibrium as *tautomeric electromers*[14]

$$C_6H_5-+SO_3H \rightleftarrows C_6H_5+-SO_3H.$$

It is self-evident that the problem of preparing two or more electromers presents far greater experimental difficulties than the separation of structure tautomers has offered in the past. When, therefore, it is recalled that von Baeyer observed the first case of tautomerism while studying isatin, and that many years elapsed before two compounds related as tautomers were actually separated as distinct substances (desmotrops), it should not be a matter of surprise that the preparation of actual electromers has not been more successful so far.

The first set of experiments, and practically the only ones, carried out with the express purpose of preparing electromers, are those of W. A. Noyes.[15] Noyes tried to prepare a nitrogen trichloride in which the chlorine atoms, like those in phosphorus trichloride, are negative

$$\mathrm{N}\begin{array}{l}+-\mathrm{Cl}\\+-\mathrm{Cl}\\+-\mathrm{Cl}\end{array}$$

No conclusive evidence in support of the existence of such an electromer could be found.

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[13] Fry, *Z. Physik Chem.*, 76, 387 (1911).

[14] L. W. Jones, *Am. Chem. J.*, 48, 26 (1912).

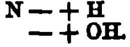
[15] W. A. Noyes, *J. Am. Chem. Soc.*, 35, 767 (1912).

In an article[16] published in the *Journal of the American Chemical Society*, I presented evidence, which I believe to be conclusive, to show that the certain derivatives of hydroxylamine, prepared by Meisenheimer, represent the first known cases of electromers, viz., compounds identical in structural formulas, but dissimilar in chemical and physical properties by virtue of a different arrangement of valence electrons, and the concomitant differences in force fields within the molecules.

A consideration of the properties of hydroxylamine, and its various derivatives and, in particular, the peculiar behavior of the hydroxyl group in such compounds, led me to conclude that this hydroxyl group could not be regarded as identical with negative hydroxyl, — OH. This opinion was expressed by Stieglitz.[17]

> The similar behavior of hydroxlamine and halogen amines, of hydroxylamine and hydrogen peroxide, still more the fundamental similarity existing between hydroxylamine and ammonia, and between their salts, and above all, the fact that, as far as the writer is aware, no hydroxylamine derivative has been found to exchange hydroxyl for halogen by treatment with halogen acids, or phosphorus halides, are facts upon which the writer's views are based. (According to a later private communication from Dr. Jones, he has now reached the same conclusion in this question and has discovered further evidence supporting it.)

These facts all imply that the hydroxyl group in hydroxylamine may be positive, $+O-+H$,



$$N\begin{array}{l}-+H\\-+H\\-+OH.\end{array}$$

Compounds of the formula $R_3N(OH)X$[18] are found among the products which result when hydroxlamine is treated with halogen alkyls. Moist silver oxide converts these substances into hydrated amine oxides, $R_3N(OH)_2$, H_2O. The same hydrated amine oxides may be prepared by the action of hydrogen peroxide[19] upon tertiary amines, R_3N. In fact, Hantzsch and Hillard[20] suggested that hydrogen peroxide might react with tertiary amines by addition and that the reaction may be reversible.

$$(CH_3)_3N + HOOH \rightleftarrows (CH_3)_3N(OH)_2.$$

By careful dehydration of hydrated amine in vacuo, amine oxides, R_3NO, are formed.

These amine oxides and their hydrates are oxidizing agents, and in this property show a striking resemblance to hydrogen peroxide. In fact, Dunstan and Gaulding, in summing up their behavior, say:

> We conclude that the oxygen is in an "active" condition analogous to the oxygen atom in hydrogen peroxide.

Thus, trimethylamine oxide rapidly decomposes in two ways:

$$2(CH_3)_3NO = 2(CH_3)_3N + O_2,$$
$$(CH_3)_3NO = (CH_3)_2NH + CH_2O.$$

These changes, looked at from the point of view presented by the electron theory, would lead to the inference that the oxygen atom in amine oxides should be represented as follows: $R_3N \overset{+}{\underset{-}{\rightleftarrows}} O$; and that the hydrated amine oxides, or their salts, should receive the following formulas: $R_3N \cdot \begin{smallmatrix}OH.\\X\end{smallmatrix}$

If the hydroxyl group in hydroxylamine be regarded as positive, and if this condition of the hydroxyl group be retained in the alkyl (aryl) derivatives, two inferences concerning the behavior of substituted hydroxylamines must follow logically.

In the first place, compounds containing in their formula the group N — OH, or the group N — OR, should show different physical and chemical properties, depending upon the nature of the hydroxyl, or alkoxyl group; *i. e.*, whether it is negative (I.) or positive (II.).

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[16] L. W. Jones, *J. Am. Chem. Soc.*, 36, 1268 (1914).

[17] *J. Am. Ch. Soc.*, 36, 288 (1914).

[18] Dunstan and Goulding, *J. Chem. Soc.*, 69, 839 (1896); 75, 1005 (1899).

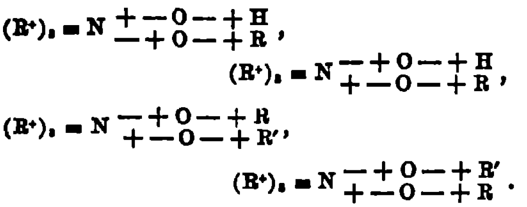
[19] Merling, *Ber.*, 25, 123 (1892); Wernick Wolffenstein, *Ber.*, 31, 1553 (1898); Mainlock and Wolffenstein, *Ber.*, 33, 159 (1900).

[20] Hantzsch and Hillard, *Ber.*, 31, 2058 (1898).

$$N + - O - + R, \qquad N - + O - + R.$$

(I.) (II.)

Then, again, provided one of the hydroxyl groups is positive and the other negative, compounds of the type, $(R)_3N(OH)_2$ should exist in two isomeric forms (electromers) when one of the hydrogen atoms is replaced by a single radical R; and, furthermore, there should be two distinct isomers (electromers) if two of the hydrogen atoms are replaced simultaneously by dissimilar radicals, R and R′.



$$(R^+)_3 \equiv N \begin{matrix} + - O - + H \\ - + O - + R \end{matrix}, \qquad (R^+)_3 \equiv N \begin{matrix} - + O - + H \\ + - O - + R \end{matrix},$$

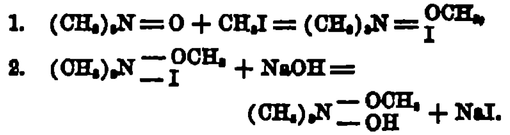
$$(R^+)_3 \equiv N \begin{matrix} - + O - + R \\ + - O - + R' \end{matrix}, \qquad (R^+)_3 \equiv N \begin{matrix} - + O - + R' \\ + - O - + R \end{matrix}.$$

In the second place, compounds of the formula R, R′, R″, $N(OH)_2$, in which there are three different alkyl (or aryl) radicals linked to the nitrogen atom, should exist in *stereoisomeric modifications*, provided one hydroxyl group is *negative* and the other one is *positive*. By the action of an optically active acid, *e. g.*, d-bromocamphorsulfonic acid, or d-tartaric acid, a racemic compound obtained by synthesis should be resolved into a dextro- and a levo-modification. Optical activity might even persist in the corresponding amine oxides R, R′, R″, $N \substack{-+\\+-} O$. Although the two hydroxyl groups are *structurally* alike, they are totally different *electronically*. Consequently, the nitrogen atom is linked to five different radicals, and, in this respect, compounds of these types may be compared to substituted ammonium derivations of the formula R, R′, R″, R‴, N — X, which have been resolved into optically active forms[21] repeatedly. Experimental evidence supporting both of these deductions has been presented quite recently.

1. *Electromers.*—In an article concerning the "Non-equivalence of the Five Valences of Nitrogen," Meisenheimer[22] describes the preparation of two isomeric compounds of the type

$$(R)_3N(OCH_3)(OH).$$

The *first* isomer was obtained by the action of methyl iodide upon trimethylamine oxide, and the subsequent replacement of iodine by hydroxyl. Thus:

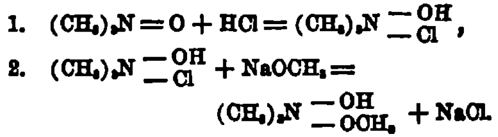


$$1.\quad (CH_3)_3N = O + CH_3I = (CH_3)_3N = \substack{OCH_3\\I}$$

$$2.\quad (CH_3)_3N \substack{-\,OCH_3\\-\,I} + NaOH = (CH_3)_3N \substack{-\,OCH_3\\-\,OH} + NaI.$$

(*A*)

The *second* isomer was secured by the action of sodium methylate upon the salt obtained by treating trimethylamine oxide with hydrogen chloride.



$$1.\quad (CH_3)_3N = O + HCl = (CH_3)_3N \substack{-\,OH\\-\,Cl},$$

$$2.\quad (CH_3)_3N \substack{-\,OH\\-\,Cl} + NaOCH_3 = (CH_3)_3N \substack{-\,OH\\-\,OCH_3} + NaCl$$

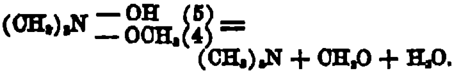
(*B*)

The two forms, (*A*) and (*B*), are identical *except for the order in which the hydroxyl groups and the methoxyl groups were introduced*. In (*B*), as Meisenheimer said, the methoxyl group is linked to the "*fifth* valence," or the one which usually engages the *acid radical;* while it is linked to the "*fourth* valence" in formula (*A*). But

[21] Le Bel, *Compt. rend.*, 112, 724 (1891); 129, 548 (1899); *Ber.*, 33, 1003 (1900); Wedekind, *Ber.*, 32, 517, 3561 (1899); 35, 766 (1902); 36, 3791 (1903); 38, 1838 (1905); Wedekind and Oberheide, *ibid.*, 37, 2718, 3894 (1904); Wedekind and Froelich, *ibid.*, 38, 3438 (1905); Pope and Peachey, *J. Chem. Soc.*, 75, 1127 (1899); Pope and Harvey, *ibid.*, 79, 828 (1901).

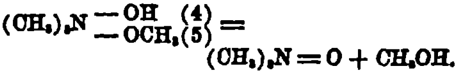
[22] *Ann.*, 397, 273 (1912).

these two substances are fundamentally different. This is easily demonstrated by a study of their solutions. When a water solution of trimethylmethoxyammonium hydroxide (*A*) was heated, it decomposed quantitatively in accordance with the following equation:

(*A*)


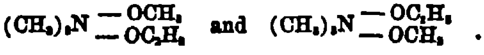
$$(CH_3)_3N \begin{matrix} -OH \\ -OCH_3 \end{matrix} \left.\begin{matrix} (5) \\ (4) \end{matrix}\right\} = (CH_3)_3N + CH_2O + H_2O.$$

While trimethylhydroxyammonium methylate (*B*) showed a totally different behavior

(*B*)


$$(CH_3)_3N \begin{matrix} -OH \\ -OCH_3 \end{matrix} \left.\begin{matrix} (4) \\ (5) \end{matrix}\right\} = (CH_3)_3N = O + CH_3OH.$$

In addition to these compounds, Meisenheimer prepared a number of isomeric mixed dialkyl compounds, with methyl, ethyl and propyl radicals, *e. g.*,

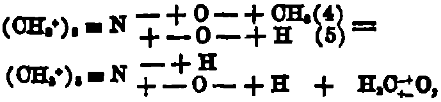


$$(CH_3)_3N \begin{matrix} -OCH_3 \\ -OC_2H_5 \end{matrix} \quad \text{and} \quad (CH_3)_3N \begin{matrix} -OC_2H_5 \\ -OCH_3 \end{matrix} \; .$$

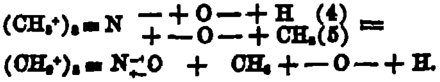
In every case, water decomposed compounds of this type to give a tertiary amine, an alcohol and an aldehyde; but, invariably, the radical which was eliminated as aldehyde was the radical which occupied "position four (4)" and the group eliminated as alcohol always occupied "position five (5)." Meisenheimer stated that he never obtained even recognizable traces of the aldehyde which should have resulted if the group attached in position five had separated in that form. His conclusions may be stated in his own words:

> Durch diese Reaktion ist bewiesen dass die beiden Alkoxygruppen nicht in gleicher Weise an das Stickstoffatom gebunden sind.

The key to these disputed relations is easily furnished in terms of the electronic conception, by assuming that the one hydroxyl (or alkoxyl group) is positive and the other negative; thus:

(*A*)


$$(CH_3^+)_3 \equiv N \begin{matrix} -+O-+CH_3 \\ +-O-+H \end{matrix} \left.\begin{matrix} (4) \\ (5) \end{matrix}\right\} = (CH_3^+)_3 \equiv N \begin{matrix} -+H \\ +-O-+H \end{matrix} + H_2O \rightleftarrows O,$$

(*B*)


$$(CH_3^+)_3 \equiv N \begin{matrix} -+O-+H \\ +-O-+CH_3 \end{matrix} \left.\begin{matrix} (4) \\ (5) \end{matrix}\right\} = (CH_3^+)_3 \equiv N \rightleftarrows O + CH_3+-O-+H.$$

It will be observed that the two groups, or, in the final analyses, the two oxygen atoms, upon which the electromerism depends, are not linked directly, but through a third atom, nitrogen.

$$RO + - \overset{|}{N} + - OH \quad \text{and} \quad HO + - \overset{|}{N} + - OR.$$

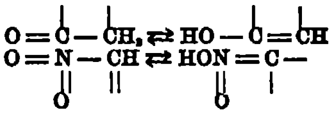
This is undoubtedly responsible for the relative stability of these electromers as compared with others in which the atoms of different polarity are directly connected; *e. g.*,

$$A + - B \quad \text{and} \quad A - + B.$$

Here, again, the analogy to structure tautomers appears. Chemists have failed to prepare desmotrops of prussic acid, and of many other compounds in which the wandering atom passes from one atom in the molecule to another directly linked to it.

$$HCN \rightleftarrows CNH.$$

The majority of successful separations of desmotrops lie among compounds in which, similar to the electromers described above, tautomeric changes involve two atoms not directly linked, but connected by a third atom. Thus, in the keto-enol and in the nitro-nitronic acid desmotrops,



the wandering hydrogen atom passes from carbon to oxygen not directly linked.

2. *Stereomers.*—Meisenheimer[28] was the first to observe that amine oxides with three different radicals R R′ R″N = O, could be resolved into enantiomorphous modifications. Amine oxides of this kind were prepared by oxidizing tertiary amines with hydrogen peroxide, or Caro's acid. Meis-

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[28] Meisenheimer, *Ber.*, 41, 3973 (1908); *Ann.*, 385, 117 (1911); 399, 371 (1913).

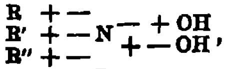
enheimer and his coworkers prepared methylethylaniline oxide, methylethyl-β-naphthylamine oxide and other similar compounds,

$$(CH_3)(C_2H_5)(C_6H_5)N=0$$
$$(CH_3)(C_2H_5)(C_{10}H_7)N=O.$$

The racemates were resolved by means of d-bromocamphorsulfonic acid or d-tartaric acid. After fractional crystallization and separation, each salt was converted into the active picrate, which was changed to the corresponding active chloride and finally into the active amine oxide itself.

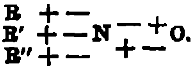
Previous attempts to resolve compounds with two like radicals, Na_2bcd, have been fruitless. Even compounds more closely allied to these amine oxides in form, such as N-methylpicolinium salts, N-methylquinolinium salts, could not be resolved by H. O. Jones.[24] Meisenheimer takes it for granted that an explanation of the stereoisomerism is provided when he has called attention to the fact that, in the amine oxides, the doubly bound oxygen engages the valence which usually holds the acid radical, while in the case of the compounds studied by H. O. Jones, only non-ionizable valences have been satisfied by doubly bound carbon.

It seems that a more consistent explanation may be offered in terms of the electronic viewpoint, if the amine oxides and their hydrates are assigned the following formulas:



$$\begin{matrix} R & + - \\ R' & + - \\ R'' & + - \end{matrix} N \begin{matrix} - \; + \; OH \\ + \; - \; OH \end{matrix},$$

I.



$$\begin{matrix} R & + - \\ R' & + - \\ R'' & + - \end{matrix} N \begin{matrix} - \; + \\ + \; - \end{matrix} O.$$

II.

It must be assumed that the linking in formula II. is similar to the grouping in formula I., in so far as its effect upon the asymmetry of the molecule is concerned, since amine oxides dissolved in benzene often show large rotations. The nitrogen atom, in either even, *does not hold two like groups,* since the properties of positive and negative hydroxyl are as divergent as those of positive and negative chlorine. In this respect, the conditions are not the same as those in ammonium compounds of the form, *Na_2bcd,* but are comparable to the condition existing in ammonium compounds of the general type, *Nabcde.*

In conclusion, permit me to express the belief that chemists will soon come to realize more fully that the recent investigations into the structure of the atom have a practical bearing upon their particular problems. The study of electromers, and the investigations of the conditions under which they may be prepared, certainly furnishes an inviting field of research, which, in my opinion, is worth tilling, and can not fail to be productive of results of far-reaching importance to chemists. Furthermore, with our present limited knowledge of the subject, no one can predict in what manner the discoveries, sure to be made, may react to modify and clarify our theories concerning the structure of matter, and, in particular, our vague notions of "chemical affinity."

Lauder William Jones
University of Cincinnati,
Cincinnati, Ohio

RECENT PHYSIOLOGY AND THE WAR[1]

This theme, kindly suggested by Professor Sir James Dewar, is sufficiently large to preclude more than a succinct treatment of some outstanding points in the time permissible in a single lecture. But these points are of considerable interest and have a more than fleeting importance.

The first is that of fatigue, its measurement and incidence in factory employees. The indices taken have been speed of output and quantity of output by groups of workpeople working under the conditions of a munitions factory. An inference of practical value drawn from the observations is that when the number of working hours per week was reduced from sixty-two to fifty-six the output actually increased. The reduction of the length of the working day by one hour per diem gave a rise of the total output of the week from an amount stated numerically as 6,150 to an amount expressed as 6,759. The output per hour increased 22 per cent. The kind of work in this case was "heavy," namely, deep screw-cutting by hand.

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[24] H. O. Jones, *J. Chem. Soc.*, 83, 1400 (1903).

[1] Address before the Royal Institution of Great Britain, February 2, 1917.

In another case, that of 200 women turning aluminium fuse-bodies, the reduction of the working hours per week from 68.2 to 60 notably increased the total output, and of course still more the rate of output. From these and other examples the lesson seems to be that there is for manual labor a certain length of working week, or working month, best suited for satisfactory production in permanence. The length varies with the class of the manual work. If a good efficiency is to be maintained in the factory this "most favorable" length of working month has to be followed. Before that it has to be found out and measured.

The next point raised was the influence of alcohol on the workers' output. The question has at present been attacked only in the laboratory so far as physiology is concerned. Physiological experiment shows that even a large single dose of alcohol—*e. g.*, 40 c.c.—has little or no effect upon the muscles *per se*, but that it does impair the working of the nervous system which actuates the muscles.

A suitable test in respect of the simplicity of the nervous centers involved in it is the knee-jerk. This is a familiar reaction to every physician; it is a reflex act, the spinal center for which has been thoroughly investigated. The effect of a single dose of alcohol of 30 c.c. quantity diluted with 120 c.c. of water is to diminish and render sluggish the knee-jerk; the speed of the response is sometimes decreased by 9.6 per cent., the amplitude of the response lessened by 48.9 per cent. The greatest impairment of the reaction was noted about one hour after the dose.

Another test of the effect of alcohol on the musculo-nervous actions was furnished by a very simple voluntary act. The person subjected to the experiment was required to move one finger to and fro, that is, to bend and straighten the finger alternately, as rapidly as possible. The rate of movement was examined before and after taking a dose of 30 c.c. alcohol diluted as above. This dose impaired the rate at which the oscillatory movement of the finger could be performed. The rate was diminished an hour after the dose by 8.9 per cent.

Such a movement is not well calculated to test that form of skill which consists in precision. Reasons were adduced for thinking that a precision of movement is that aspect of a muscular act which will be most detrimentally interfered with by alcohol. The testing of alcohol effect by the ergograph seems to show that a moderate dose, say 30 c.c. of alcohol, in a person accustomed to moderate use of alcohol, does not appreciably impair the power of the movement nor its resistance to fatigue. But the movements chosen as suitable for ergographic record are such as give little opportunity for the exhibition of precision or of skill of any kind.

The next point dealt with was the attempt to devise some fluid which can be injected to counteract the effect of severe loss of blood in the wounded. The properties desirable for the required fluid were shown to be: harmlessness in respect of avoidance of causing clotting in the circulation; restoration of the volume of the fluid in the circulation; maintenance of the due degree of viscosity of the circulating fluid, since on that factor depends the arterial and capillary pressure; and, finally, preservation of the balance between the osmotic pressure of the fluid inside the blood-vessels and outside in the tissues. It was shown that considerable success had been reached in this problem by the experiments of Professor Bayliss and others.

A final point dealt with was the treatment of tetanus by administration of "anti-tetanus serum." This serum is obtained from the blood of horses which have been subjected to gradually-increasing doses of tetanus-toxin, the poison produced by the tetanus-bacillus. The high efficiency of this anti-toxic serum when used as a prophylactic was first demonstrated on man on a large scale by its employment in the first autumn of this war. Curves illustrating the statistics were shown. The severe outbreak of tetanus which ensued in the troops at the outset of the campaign was checked and practically stopped almost instantaneously by the orders that every wounded man, as soon as possible after being wounded, that is to say, at the first field casualty-station, should receive a small injection of anti-tetanus serum from the immunized horse. But the efficacy of the serum when once signs of tetanus have appeared in the patient is far less satisfactory. The remainder of the lecture was devoted to discussion of why this should be, and in what ways the difficulty may be, at least in part, overcome.

CHARLES S. SHERRINGTON

PRE-MEDICAL TRAINING IN CHEMISTRY[1]

As a country we are rubbing the sleep out of our eyes and wishing we had split the kindling and brought up the coal the night before. The alarm clock has been ringing for some time, but we have preferred our dreams of ease to the realities of necessities.

The medical profession is awake and trying to start the water boiling, but finds it can not lay the fire. The wood and coal are at hand, but the knowledge of their proper use is lacking. Now, more than ever, do progressive physicians realize the dependency of successful practise on a well-founded knowledge of the chemistry of the human body, and more than ever do they irritably contemplate their lack of preparation.

This lack of preparation in a science so obviously fundamental to rational understanding of the human mechanism as to require no elaboration, at present exists; that a continuation of this condition should be allowed is a parody upon our intelligence.

The futility of expecting the physician to utilize all possible sources of relief to suffering without a knowledge of the application of basic chemical principles to the body reactions is apparent.

It is equally as absurd to expect the medical student to appreciate or assimilate the possibility of chemistry being a practical science for his uses, if he does not have sufficient foundation in this subject before he enters the medical school. The medical school is fundamentally a school of applied science. It is where the individual is taught science as applied to the human body. Any attempt to teach a student biological chemistry without his having received an adequate foundation in the fundamental principles of chemistry in general, and to expect him to know much of anything when we are through with him, is as idiotic as to try to teach calculus to men who have yet to know algebra. The foundation must be laid in the pre-medical work.

It is only in recent years that the teaching of elementary chemistry has been dropped from the medical curriculum. Unfortunately however even to-day it is only the few schools interested in turning out doctors instead of groups of men competent to pass State-board examinations, that have adapted themselves to the logical demand of the times as justified by the ever-increasing applicability of chemical science to medical practise, and brought about this necessary change.

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[1] Read before the Division of Biological Chemistry, American Chemical Society, Boston, September, 1917.

It is admitted that plausible excuse for this disorderliness exists. The appearance of chemistry as a real aid to diagnosis and treatment from the Stygian darkness has been not only remarkable for the rapidity of its development, but amazing in its stability. A new phase in medical knowledge has been produced through the pressure of the discoveries of countless investigators. And it is not surprising that the now should-be obsolete system clings tenaciously to the older but invalid conceptions.

It is well recognized that the efficient practise of medicine entails a scientific knowledge of ever-widening scope. It is therefore of the greatest importance that a proper selection of scientific information be presented to the prospective medical student for his assimilation. Purposeless instruction, from the point of view of the pre-medical student, is haphazard and yields results that are worse than nothing.

Conscientious objectors will mentally raise the objection that the pre-medical requirements are already well set down in the regulations of the various medical schools and by the American Medical Association. From the quantitative standpoint this is largely true, but from the point of quality the field is barren. And whereas these dicta were sufficient for the time and admirable in that an appreciation of the increasing importance of chemistry to the practise of medicine was shown, yet such advantages are now possible to be derived from a more exact definition of requirements that a change is imperative, else stagnation will set in. For mark you, while directions are given that so much inorganic, and so much organic, and so much advanced chemistry should be given, nothing is said about what of inorganic, and what of organic or what of advanced should be taught. To chemists it is a matter of individual experience that any of the various branches of the science can well occupy the studies of a lifetime.

So why try to make the pre-medical student a chemist. He wants to be a doctor, and he wants to learn what of chemistry there is that can help him to be a better doctor. But instead of getting what he wants he is put through the mill with the students who wish to enter upon chemistry as a life work, gets so far and no farther, wonders what it is all about, takes a good dose of physic in the form of an examination and gets rid of all he had taken in. If the college instructors of pre-medical students should look upon them as a problem in research, the results would never see the light.

Now this pre-medical training in chemistry is essentially a question of *what* instead of *how much,* and the decision as to the subject-matter to be offered for utilization is not especially difficult if one cares to look into a biological chemistry for a few hours. What the pre-medical student needs is to learn the fundamental principles common to all chemical reaction. He does not need encyclopedic details. Principles are to details as granite is to points in the work, they should not be obscured by a fog of wearying and relatively unimportant details. Let me illustrate: the understanding of the nature of oxides is a principle, the number and formulæ of the oxides of iron is an unessential detail, and again, the phenomena of isomerism is a principle, the ability to enumerate all possible isomerides of a given compound is detail.

Principle must not be subordinated to detail.

Human health and happiness rests to a great degree in the physician's hands. The true physician must be a true diagnostician. He can not be a diagnostician if he lacks power of observation and ability to carry on deductive reasoning. Where better can he gain this fundamental training than in chemistry? And can he get this point of view in a mind befuddled with inconsequential detail? Another essential attribute of the efficient doctor is technique. The ability to rapidly, smoothly and accurately carry on delicate manipulations is a prime requisite for adequate medical service. What teaches this better than intensive training in quantitative analysis? Can we conclude from the results handed over to us that these things have been done? We can not.

Any teacher of biological chemistry in a medical school knows how flimsy a chemical structure has been erected in the minds of the students coming to him, and that the information acquired is about as useful as is a cobweb for catching fish.

The causes of this are self-evident. Probably the most satisfying reason lies in the newness of the possibilities of the application of the science of chemistry to diagnosis and treatment. The collegiate instructor has failed to appreciate the progressive utilization of chemistry by the biological sciences. There is a chasm between what the instructor knows and attempts to teach to the pre-medical student and what the pre-medical student needs. And as a result the student falls into the chasm, and is lost. It is the job of the collegiate instructor to bridge the gap through constructive cooperation. The medical-school instructor has not been sufficiently insistent on preliminary requirements from a qualitative standpoint, nor has he shown any special inclination to relate the needs of the situation. These facts when coupled with the disinclination of the college teacher of chemistry to break away from the classical and now obsolete methods of teaching and inaugurate a system adapted to the demands of the times give some explanation of what at present confronts us. There is at hand a supply of potential useful information that lacks efficient assimilation because of the lack of understanding of fundamental principles.

The remedies are obvious—an attempt by the collegiate instructor in chemistry to learn something of what chemistry is doing in biology, a measure of cooperation between teachers of biological chemistry and the pre-medical instructors, a willingness on the part of the latter to recognize the validity of the wishes of the former, an outline of preparedness from the qualitative point of view, and a realization that true preparedness rests on understanding, while understanding can only come when detail is subordinated to principle.

FREDERICK S. HAMMETT

HARVARD MEDICAL SCHOOL

SCIENTIFIC EVENTS

BRITISH EXPERIMENTAL STATION FOR FUEL RESEARCH

THE Fuel Research Board of the Department of Scientific and Industrial Research has issued a report, signed by Sir George Beilby, the director of fuel research, describing the scheme of research they have adopted and their plan for the establishment of a fuel research station on an industrial scale.

It is stated in the London *Times* that in a previous report, which has not been published, they stated that they had in view two main lines of research: (1) A survey and classification of the coal seams in the various mining districts by means of chemical and physical tests in the laboratory, and (2) an investigation of the practical problems which must be solved if any large proportion of the raw coal at present burned in its natural state is to be replaced by the various forms of fuel obtainable from coal by processes of carbonization and gasification.

At one time it was thought that the former line of inquiry could be proceeded with in advance of the second, but further consideration has shown them to be so interdependent that they can be most satisfactorily dealt with side by side. However, in preparation for the organization of the first line of inquiry, an experimental study of standard methods for the examination of coal in the laboratory has been made, and as the result of work carried out for the board in the Fuel Laboratory of the Imperial College of Science a test has been elaborated which, by direct weighing and measurement, gives the yields of gas, oil, water and carbonaceous residue that result from carbonization at any definite temperature.

Among the problems to be investigated are:

1. Can the 35 to 40 million tons of raw coal used every year for domestic heating be replaced wholly or partially by smokeless fuel, solid or gaseous, prepared by the carbonization of this coal?

2. Can adequate supplies of fuel for the Navy be obtained by carbonizing the coal at present used in its raw form for industrial and domestic purposes?

3. Can supplies of town gas be obtained more economically and conveniently by methods of car-

bonization and gasification other than those now used in gas works?

4. Can electric power be obtained more cheaply if the coal used for steam raising is first subjected to processes of carbonization and gasification?

5. Will the more scientific development of the preparation and use of fuel, which would be implied in the successful working out of the foregoing questions, enable the peat deposits of the United Kingdom to take a serious place as economic sources of fuel for industrial purposes?

6. Can the use of gaseous fuel in industrial operations be forwarded by the development of more scientific methods of combustion in the furnaces, muffles and ovens used in metallurgical, ceramic and chemical operations?

Answers to these questions, the report points out, will be obtained only by coordinated research carried on the lines of a broad and well-considered scheme, but at the same time the Fuel Research Board think it is to be expected that solutions of some of the problems will be supplied by workers in the industries, and they would regard it as a great misfortune were the establishment of a government organization for fuel research to result in discouraging or in any way limiting the activities of outside workers or organizations.

It was realized that the conditions required for the research station could be fulfilled only by a site in the neighborhood of a large gas works. Some months ago the director of Fuel Research approached Dr. Charles Carpenter, the chairman of the South Metropolitan Gas Company, and subsequently Dr. Carpenter on behalf of the directors of his company, made the following very generous offer:

1. To lease the government at a peppercorn rent sufficient land at the East Greenwich gasworks for the erection of the research station.

2. To prepare drawings and specifications for the station on lines laid down by the board and to make contracts for its erection; and

3. To give every facility for the transport of coal and other supplies to the station and to take over at market prices the surplus products, gas, tar, liquor and coke, resulting from the operations of the station.

The site consists of a strip of level ground, about 250 feet wide by 700 feet to 800 feet long, situated on the main siding which connects the gas works with the South-Eastern Railways and possessing access to an existing road. The station, as planned, will be capable of any extensions required for future researches. Of the four acres to be leased, only one acre will be occupied by buildings under the present scheme. Further, a large part of the equipment of the buildings will be of a permanent character and will serve all the general purposes of a research station. Future extensions, therefore, will not repeat this permanent equipment, but will be based upon it.

THE COLUMBIAN INSTITUTE

THE great scientific bureaus of the government at Washington with their thousands of employees dealing with the country's problems in every branch of science, and the important learned societies and scientific establishments of the national capital, were influenced in their early growth and development in a greater or less degree by a scientific society which flourished in Washington during the early years of the last century. The Columbian Institute for the Promotion of Arts and Sciences, now all but forgotten, was the first learned society established in Washington, its organization dating from June, 1816, sixteen years after the occupation of the city as the federal capital, and less than two years after the invasion by the British troops. The population of Washington was at that time little more than 10,000, and the repair and reconstruction of the public buildings was still in the initial stage. The history, organization and achievements of this society are fully described in an interesting Bulletin of the United States National Museum by Mr. Richard Rathbun, assistant secretary of the Smithsonian Institution, in charge of the National Museum.

The objects of the Columbian Institute, which was chartered by Congress in 1818 for a term of twenty years, were as a whole very diversified, those specifically named in the beginning having been almost wholly of a utilitarian nature, such as the government has from time to time assumed and made the basis of the work of several scientific bureaus.

Four years later, however, an organization was adopted which gave to the Institute the latitude of a comprehensive learned society. Among all the activities planned only a few were in any way conspicuously carried out, in default of the necessary support, the most important and material of these being the establishment of a botanic garden and a museum. The former occupied the extreme eastern end of the Mall which then approached much nearer the capitol than at present, and included the site of the present United States Botanic Garden.

Starting with a cabinet of minerals which remained predominant in this connection, this feature soon developed into a general though small museum, containing specimens of zoology, botany, ethnology, archeology, fossils, etc. Transferred to the National Institution in 1841, some of the objects are now readily distinguishable in the United States National Museum, forming, it may be claimed, the nucleus of its collections.

The institute obtained its meeting places and accommodations for its museum mainly through the favor successively of the executive departments, the municipal government, and Congress. It was first located in Blodget's Hotel, containing the general post office and the patent office, followed by the treasury department and city hall, being finally assigned a permanent home, in 1824, in the western addition to the capitol building, which had just been completed. The use of the site for its botanic garden was also a grant from Congress.

However unfortunate in the realization of its ambitions, the Columbian Institute nevertheless occupied an enviable position among the earlier associations of this country for the breadth and importance of its object, even if they be regarded only in the nature of suggestions, which have since been so fully recognized in the organization of the government and elsewhere, and for its hearty and unselfish efforts to carry them out. The Columbian Institute owed its establishment and early successes to a masterful mind, that of Dr. Edward Cutbush, then a surgeon in the Navy, and the first president of the society, though acknowledgments are also due to Thomas Law for the suggestion of such a society at the seat of government.

The membership of this institute included a great many of the prominent men of every walk of life in Washington, among them John Quincy Adams, Andrew Jackson, John C. Calhoun, Henry Clay, and well-known representatives of the Army, the government service, the medical and other professions.

AWARD OF THE JOHN SCOTT LEGACY MEDALS AND PREMIUMS AND OF THE EDWARD LONGSTRETH MEDAL OF MERIT

The city of Philadelphia, acting on the recommendation of The Franklin Institute, has awarded the John Scott Legacy Medal and Premium to Alfred Rishworth Tattersall, of London, England, for the "Midget" Marvel Flour Mill.

This device is a small and simple form of flour mill, designed to enable local millers to make a good grade of flour at a comparatively low cost. It is of especial value in farming communities in which the flour mills run by water power have been abandoned.

And has also awarded the John Scott Legacy Medal and Premium to Max Ulrich Schoop, of Zurich, Switzerland, for the Schoop Metal Spraying Process.

In this process, wire of some easily fusible metal, like zinc, is fed into a device called a spraying pistol. The wire passes through a tube and at its end comes into contact with burning gas, by which it is melted, and the molten metal is sprayed by an air blast upon the surface to be covered. The use of this process has been found to greatly increase the life of patterns for castings.

The John Scott Legacy Medal and Premium has also been awarded to Thomas A. McCall, of South Akron, Ohio, for his inventions embodied in the early development of the Hooven Automatic Typewriter, and to John H. Pillings, of Hamilton, Ohio, for his inventions and improvements embodied in its later development.

The Franklin Institute has awarded its Edward Longstreth Medal of Merit to The

Hooven, Owens, Rentschler Company, of Hamilton, Ohio, for the development of ingenious methods used in the manufacture of this typewriter.

This machine is capable of producing typewritten form letters much faster than they can be written in the ordinary way.

SCIENTIFIC NOTES AND NEWS

A SPECIAL board of chemists to investigate explosives, the uses of gases in warfare and to act as advisers to the Bureau of Mines, has been appointed. The board will study the problem of increasing the production of materials used in explosives manufacture and will advise the bureau in the operation of the recently enacted law regulating the sale of explosives. The members are: Dr. William H. Nichols, of the General Chemical Company, New York, chairman; Professor H. P. Talbot, head of the chemical department of the Massachusetts Institute of Technology; William Hoskins, of Chicago, a consulting chemist; Professor H. P. Venable, of the University of North Carolina; Professor E. C. Franklin, of Stanford University, and Dr. Charles L. Parsons, of the Bureau of Mines.

PRESIDENT J. G. SCHURMAN, of Cornell University, has announced that the State Food Commission, of which he is a member, had completed its organization. Its work is now in three divisions—production, under Commissioner Wieting; distribution, under Commissioner Mitchell, and conservation, under Commissioner Schurman. For each of these divisions a bureau has been established with a director at its head. Calvin Huson, a former commissioner of agriculture, heads the bureau of production, and Cyrus Miller, a lawyer of New York City, the bureau of distribution. Professor Howard E. Babcock, of the State College of Agriculture at Cornell, now director of Farm Bureaus, has been appointed director of the bureau of conservation. Professor Babcock will receive a leave of absence from the university for the period of his service with the Food Commission.

THE mission sent to France by the Rockefeller Foundation to assist in combating the threatened increase of tuberculosis has decided to work in three sections under the general direction of Dr. Livingston Farrand. The first section will establish in one of the arrondissements of Paris and in certain large provincial towns a complete antituberculosis organization consisting of dispensaries, clinics and laboratories, with provision for domiciliary attendance. This section will be directed by Dr. Miller. A second section, under Dr. Charles White, will undertake the distribution of assistance. A third section, under Professor Gunn, will be concerned with the education of the public; it has already commenced to organize traveling exhibitions, meetings and kinematograph displays.

THE British Industrial Research Committee of the Board of Education have made a grant to Professor G. H. Bryan, F.R.S., of the University College of North Wales, which will enable him to devote the whole of next session to the carrying on of some special research work in aeroplane construction of national importance. In the first instance Professor Bryan proposes to work at the University of Bristol.

THE following-named officers, Engineer Officers' Reserve Corps, are relieved from duty at the Engineer training camp, and will report by letter to the director, United States Geological Survey, for assignment to duty connected with military mapping: From Fort Leavenworth, Kans., Second Lieutenants Elmer LeC. Goldsmith, John W. Lewis, Edward J. Francis, Elmo N. Murphy, Carl R. French, William D. Lewis, and Charles B. Moore. From American University, District of Columbia, Second Lieutenants Charles M. Madden, Edward H. Stelle, Frederic E. Smith, Edward P. Asbury, George B. Davidson, Frederick W. Look, Gordon D. Cooke, Joseph W. Geary, Jr., and Walter K. Wood, and also Second Lieutenant Herman J. Switzer, Engineer Officers' Reserve Corps.

MR. A. H. GILBERT has accepted a position as a pathological inspector with the Federal Horticultural Board with headquarters at Washington, D. C. Mr. Gilbert was formerly associate professor of botany at the University of Kentucky.

Under a grant from the American Association for the Advancement of Science, Dr. C. H. Kauffman spent the month of August, 1917, in the state of Colorado studying the genus *Cortinarius* for his proposed monograph. In September, Dr. Kauffman began his work as a pathological inspector with the Federal Horticultural Board with headquarters at Washington, D. C.

The Herbert Spencer Lecture for 1917 was delivered by Professor Emile Boutroux, member of the "Institut" and the French Acadamy, and Doctor of Letters of the University of Oxford, on October 20, in the Oxford University Museum. The subject of the lecture was "The relation between thought and action from the German and from the classical point of view." The lecture was delivered in English.

The Bradshaw Lecture on "The causes of disease" was given before the Royal College of Physicians on November 8 by Professor Ernest S. Reynolds, physician to the Manchester Royal Infirmary. The FitzPatrick lectures were delivered on November 13, 14 and 15, by Dr. Arnold Chaplin, known for his studies of the Napoleonic period, on "Medicine in England during the reign of George III."

Dr. J. S. Flett gives this year the course of twelve Swiney lectures on geology at the Royal Society of Arts on Tuesdays, Thursdays and Fridays, beginning on Tuesday, November 13. The subject is "The Mineral Resources of the British Empire."

Memorial services were held at Cornell University Medical College for the late Dr. Lewis A. Stimson, professor of surgery at the college from the time of its foundation in 1898 to his death on September 17, this year. Among the speakers were Mr. Elihu Root, President Jacob Gould Schurman, of Cornell; Dr. Gilman Thompson, professor of medicine, emeritus; Howard Townsend, president of the board of governors of New York Hospital, and Dr. Edward L. Keys.

Professor Edward Hull, LL.D., F.R.S., late director of the Geological Survey of Ireland, died on October 18, in his eighty-ninth year.

A bronze tablet commemorating Dr. Simon Baruch's connection with the campaign for public baths in New York City was unveiled at the Simon Baruch Public Baths, formerly the Rivington Street baths on October 29. The tablet was donated by Mrs. Belle Baruch through the Association for the Promotion of Hygiene and Public Baths. Borough President Marcus M. Marks made the address of acceptance in behalf of the city.

Nature states that the late Mr. Cawthron left £250,000 to the city of Nelson, New Zealand, for scientific research. The trustees are the bishop of the diocese, the member for the district, the mayor of Nelson, two chairmen of local bodies and a personal friend of the deceased. The site of the proposed institute has been purchased, and the appointment of a director and staff is under consideration. The object of the institute is, primarily, scientific research work for the benefit of the province of Nelson and the Dominion of New Zealand. The province of Nelson is mostly concerned with fruit, agriculture and minerals.

UNIVERSITY AND EDUCATIONAL NEWS

By recent decision of the court Wilberforce University has come into possession of $30,000 of the Charles Avery estate in Pittsburgh. The fund is to be used for endowment purposes.

Committees representing Leander Clark College, of Toledo, and Coe College, of Cedar Rapids, recently voted to merge these two institutions. Coe College will absorb Leander Clark with its endowment of about $250,000.

Sir William Tatem has given £25,000 for a laboratory at the University College of South Wales, Cardiff.

As has been already announced Dr. Ralph H. McKee has been appointed to take charge of the graduate work in industrial organic chemistry (department of chemical engineering) at Columbia University, New York City. Dr. McKee was at the head of the department of chemistry of the University of Maine from 1909 to 1916, leaving this position a year ago to enter commercial chemical work in New York City as head of the research department of the Tennessee Copper Company. While at Maine he initiated and developed the department for the making of pulp and paper, the first of its kind to be established in any college in this country.

THE personnel of the department of geology and mining engineering at Iowa State College, Ames, Ia., is now as follows: Head of department, Dr. S. W. Beyer, who is also dean of the division of engineering, vice A. Marston, now major of the Battalion of Engineers, Iowa National Guard; L. C. Hodson and Dr. S. L. Galpin, associate professors of mining engineering; H. F. Staley, professor of ceramic engineering; Dr. Chas. A. Mann, associate professor of chemical engineering; John E. Smith, assistant professor of geology.

DR. J. E. MARR, University lecturer in geology in Cambridge University, has been elected to the Woodwardian professorship of geology in succession to the late Professor McKenny Hughes.

F. DE QUERVAIN, professor of surgery at the University of Basle, has accepted a call to the medical faculty of Berne as successor to Professor Kocher.

J. JADASSOHN, professor of dermatology at the University of Berne, has been appointed professor in Breslau in succession to Professor Neisser, who died some months ago.

DISCUSSION AND CORRESPONDENCE

AN EXTRAORDINARY RAINFALL RECORD

DURING a recent visit to the Hawaiian Islands, I had occasion to do some collecting on Kauai, the northern island of the group. While there I made a trip to a region of such extraordinary precipitation that it seemed worthy of record.

The island is almost circular in outline, rather less than thirty miles in its greatest diameter. It consists for the most part of a plateau averaging about 3,500–4,000 feet in elevation, but rising to a little over 5,000 feet at Mt. Waialeale, almost in the center of the island.

As in all the Hawaian Islands the windward (NE.) side has a very heavy precipitation, while on the leeward side the rainfall is very light.

The central part of Kauai, culminating in Mt. Waialeale, has the heaviest precipitation of any station in the Hawaiian group, and can be equalled by very few regions anywhere, where rainfall data have been kept. In one year over 600 inches fell, and for the five years—1912–1916—the average was slightly more than 500 inches.

Waialeale is seldom free from rain clouds, and the precipitation is almost incessant. In consequence the whole region near it is a bog, partly covered with a forest of low trees, thickly draped with dripping masses of mosses and liverworts, but a good deal of the region, including the summit of Waialeale, is an open bog, covered with coarse grasses and sedges, with a few stunted shrubs and various characteristic bog plants.

TABLE I

Precipitation at Waialeale, Island of Kauai, Territory of Hawaii

Elevation above sea level 5,075 feet

Year	Rainfall in Inches
1912	399.35
1913	453.00
1914	610.00
1915	590.00
1916	539.70

Precipitation at Waimea Village, Island of Kauai, Territory of Hawaii

Elevation above sea level 10 feet

Year	Rainfall in Inches
1912	20.50
1913	23.58
1914	24.50
1915	13.40
1916	22.05

Distance Waimea to Waialeale (air line) 13.5 miles.

My guide on this expedition was Mr. W. V. Hardy, hydrographer of the United States Geological Survey, who has been keeping records on Mt. Waialeale for the past six years. I am under great obligation to Mr. Hardy for many kindnesses, and I am indebted to him for the accompanying tables. The second table shows the rainfall data for Waimea, a village on the leeward coast of Kauai.

Douglas H. Campbell
Stanford University,
California

QUOTATIONS

THE ROCKEFELLER HEALTH RESEARCHES[1]

The third annual report of the Rockefeller Foundation, the International Health Board (known previously as the International Health Commission), deals with the year 1916. The general summary, which precedes the details of different states and countries, shows that in addition to ankylostomiasis, malaria and yellow fever have been dealt with, and this would seem to indicate that the Board is prepared to tackle all tropical disease where the necessity arises. As regards the first of these scourges, ankylostomiasis, it is stated that active measures to control and prevent the disease are now in operation in Kentucky, Louisiana, Mississippi, North and South Carolina, Tennessee, Texas, and Virginia in the United States; in certain West Indian islands—Antigua, Grenada, St. Lucia, St. Vincent, and Trinidad; in British and Dutch Guiana, Costa Rica, Guatemala, Nicaragua, Panama, Salvador, in South America; and in Ceylon and Siam in the East. Such widespread work, properly controlled as this is, and with no lack of funds to support it, is bound to do good, and, though remarkable results can not be looked for in a few years, nevertheless results will come, all in due time. To ensure this, permanency of the work is essential, as otherwise matters would quickly drift back. The sanitation of many of the small tropical towns and villages at the present day is very similar to that which existed in England a hundred years ago, and only time and much labor will bring them into line with modern sanitary ideas. As many tropical maladies are insect-borne, study of the habits of the insects concerned is essential, and engineering works, large and small, may be required to abolish their different breeding grounds. The importance of collective investigation and organized campaigns in such a task is manifest, and it is here that the great value of the efforts of the International Health Board lies. The report describes fully the means adopted in the fight against ankylostomiasis. Of great interest also is the work of the commission appointed by the board to inquire into the problem of yellow fever centers in South America. The report states that the only endemic center of the disease in South America at present is Guayaquil, Ecuador, though certain sections of Colombia, Venezuela, and the adjacent West Indian Islands are also under suspicion and require close observation. The eradication of the disease, with this knowledge as a guide, is feasible. The report suggests that Mexico and West Africa should similarly be examined. Experiments upon the control of malaria have also been commenced, and those will be extended in due course. Further, a new school of hygiene and public health has been established in Baltimore by the Rockefeller Foundation in connection with the Johns Hopkins University, and is to be opened this month with Dr. William H. Welch as director. Three main purposes will be served by the new school: first, to furnish trained men on whom the board may draw; secondly, to serve as a training center to which students from other countries may be sent for instruction; and, thirdly, to provide a laboratory for solving scientific problems which arise. This Rockefeller Foundation is a splendid conception. Untrammelled by questions of expense, its activities are unlimited, and the benefits it can and will bestow upon mankind in the tropics are inestimable. It is a dream the original workers in tropical medicine often dreamed, and it has come true. Finally, a word of congratulation is due to Dr. Wickliffe Rose, its able director-general, for the work he has already accomplished. Long may he continue to direct its energies.—*British Medical Journal.*

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[1] N. Goormaghtigh, *Arch. méd. Belges*, Paris, 1917. Tome LXX., p. 697.

SCIENTIFIC BOOKS

On Growth and Form. By D'ARCY WENTWORTH THOMPSON. Cambridge University Press. 1917. 8vo. 779 pages with 408 text-figures.

In the author's own words the purpose of his book is to show "that throughout the whole range of organic morphology there are innumerable phenomena of form which are not peculiar to living things, but which are more or less simple manifestations of ordinary physical laws." This thesis Professor Thompson elaborates in a most interesting manner, developing with the aid of our fuller knowledge of physical forces and of the conditions under which they act, the mode of study initiated by Borelli many years ago, and applied, more recently, with striking and suggestive results, to several forms of organic activity by Rhumbler, Leduc, Przibram, Macallum and others. These results and many others less familiar receive clear exposition, but the book is far from being a mere compilation, a refreshing originality, being characteristic both in subject matter and in the manner of its presentation.

The contest between the vitalistic and mechanistic views of the phenomena of life has been carried on by generation after generation of men and always with the strategic results of the struggle in favor of the mechanists, as one vitalistic stronghold after another has fallen. The attack is drawing ever nearer to the central citadel and Professor Thompson's book is a massing of the attacking forces before this citadel. But the author with all his enthusiasm, recognizes limitations in his resources. "Nor do I ask of physics," he says," how goodness shines in one man's face and evil betrays itself in another. But of the construction and growth and working of the body, as of all that is of the earth earthly, physical science is, in my humble opinion, our only teacher and guide." Psychic phenomena are outside the limits of his attack. Even with this limitation, however, the book is one of the strongest documents in support of the mechanistic view of life that has yet been put forth.

It would be difficult to give an adequate résumé of the contents of a book, so crowded with facts and ideas of the greatest interest to morphologists; it must suffice merely to mention some of the problems treated. One finds an interesting discussion of the physical factors determining the size of organisms, especially interesting being the consideration of the conditions which may determine the minimum size of a living organism. This is followed by a chapter on the factors determining growth and then follow chapters on the structure and form of the cell, in which the phenomena of karyokinesis are regarded as "analogous to, if not identical with those of a bipolar electric field," and the forms assumed by organisms as expressions of the law that a liquid film in equilibrium assumes a form which gives it a minimal area under the given conditions. In this connection Professor Thompson expresses the opinion that in the simpler organism, whose form is due to the direct action of a particular physical force, similarity of form is not necessarily an indication of phylogenetic relationship.

The form of the cell in cell-aggregates is then taken up, the arrangement of the division planes being considered as illustrations of the principle of minimal areas, and the author then passes on to the consideration of concretions and spicules. This involves as an essential problem the question of crystallization in the presence of colloids, a question concerning which there is much yet to be learned. The further discussion of the forms assumed by spicules leads to their division into two groups, those of intracellular origin and those that are intercellular, linear growth of the former under restraint leading to forms which have for their mathematical basis geodetic curves, while in the case of the latter the phenomena of adsorption and the deposit of the crystalline material on interfaces are held to be sufficient for the explanation of even the marvellously complicated radiolarian skeletons.

The mathematical properties of the logarithmic spiral as applied to the forms shown by molluscan and foraminiferal shells are then discussed and from this to a consideration of the form of horns and tusks the passage is easy. A brief discussion of phyllotaxis follows and is succeeded by a chapter on the shapes of eggs and other hollow structures, after which one finds an interesting description of the mechanical principles illustrated by the structure of individual bones and by the skeleton as a whole. The concluding chapter is an exposition of Professor Thompson's method of comparing the form of different organisms, or of their parts, by inscribing, for example, the outline of the skull of *Hyracotherium* in a system of Cartesian coordinates and then determining the deformation of the system necessary for a similar inscription of the outline of the skull of a horse. A graphic representation is thus obtained of the manner of growth characteristic of this particular line of evolution, and the method may thus serve in certain cases as a test of phylogenetic affinity.

This brief outline may give some idea of the scope of the book, but it altogether fails to indicate the interesting and suggestive manner in which the various topics are treated. Professor Thompson's style is marked by a clearness of expression which makes every page of interest and his book is one that may well be recommended as revealing food for thought and fields for investigation which have been too much neglected by students of morphology. J. P. McM.

Tsimshian Mythology. By Franz Boas. Based on Texts recorded by Henry W. Tate. Paper accompanying the Thirty-first Annual Report of the Bureau of American Ethnology, 1909–1910. Washington, Government Printing Office, 1916. Pp. 1037; 3 plates; 24 text figures.

The core of this paper consists of English versions of sixty-four Tsimshian myths and three war tales, written down for the author by Mr. Henry W. Tate, a Tsimshian Indian of Port Simpson, B. C., in his own language, between 1902 and the year of his death, 1914. The translations were made by Professor Boas on the basis of "a free interlinear rendering by Mr. Tate."

However, unlike most ethnologists who have published Indian stories, Professor Boas has not rested satisfied with the mere printing of "material," important as such publication undoubtedly is, nor even with the addition of comparative footnotes. He has made this work the occasion and the basis for studies of several different aspects of Tsimshian ethnology, and for what is by all odds the best investigation of the distribution of American myths and mythic elements which has so far appeared, one which goes a long way toward satisfying the often-voiced demand for a concordance of American myths. Besides the usual tables of contents, bibliography and alphabet explanatory of the characters representing native sounds used in the work, it contains an introductory description of the Tsimshian, and, best of all, a summary of the comparisons and a detailed index to the references used in the comparison, the latter prepared with the assistance of Dr. H. K. Haeberlin. In appendices III. and IV. students of American Indian languages will find useful material regarding the speech of the people among whom these myths were current. The work is also used as a medium for the publication of seven Bellabella and ten Nootka tales, by Dr. Livingston Farrand and Mr. George Hunt respectively.

The longer studies to which reference has been made are "A Description of the Tsimshian, Based on Their Mythology" (pp. 393–477), a treatise on "Tsimshian Society" (pp. 478–564), and finally the "Comparative Study of Tsimshian Mythology" (pp. 565–871), already mentioned as the crowning feature of this work.

While the value of myths as sources of information regarding the general ethnology of the tribe from which they were collected has frequently been commented upon, so far as I am aware we have here the first attempt to write an ethnological description based entirely upon them. For this reason, if for no other, the result is of interest. It shows that Tsimshian stories contain an incomplete, but upon the whole trustworthy, picture of native life and thought. On the one hand this must be supplemented by the introduction of matters too well known among his people to be explained by the storyteller, and on the other by determining in how far the conception of what ought to be in the social and religious lives of the people conformed to things as they actually were.

The discussion of Tsimshian society derives a large part of its importance from the fact that it concerns one of the two areas over the data from which controversies regarding "the origin of totemism" have raged most violently. Evidence of the entire absence of such a thing as totemic taboos and of the importance of the father's as well as the mother's clan in the life of the individual are therefore of interest, as also the comparative study of the distribution of crests among the matrilineally organized peoples of this region. The general discussion of totemism on pages 515 to 519 should be read carefully by all interested in that subject.

In his treatment of the evolution of the north Pacific clan systems Professor Boas follows his usual cautious method. He criticizes adversely the reviewer's theory regarding a former extension of the Tlingit over what was later the Tsimshian coast, as also his suggestion that Haida moieties have arisen as the result of the amalgamation of two distinct peoples. The evidence for the former view was, however, not entirely traditional, being based partly on the presence of a considerable number of animal names in Haida identical with those in Tlingit, and the comparative lack of similar Tsimshian names, although in historic times relations between the Haida and Tsimshian were much more intimate than between the Haida and Tlingit.

To prepare the comparative study of Tsimshian mythology an enormous amount of painstaking work was necessary, particularly in the analysis of the various versions of the Raven legend, and future students will be saved an incalculable amount of labor. Two or three more efforts of the same kind would result in the much-desired concordance. The results of this comparison are summarized on pages 872-881, the more important points being the following.

As forecasted in Boas's "Indianische Sagen," published in 1895, Tsimshian mythology is distinguished from the mythologies of other Pacific coast peoples by the presence of a large number of tales of inland origin. An examination of the content of the material generally shows "that there are a number of very simple plots, which have a wide distribution, and which are elaborated by a number of incidents that have a very wide distribution and occur in a variety of plots." Comparing European and North American folk-lore Professor Boas finds that "European folk-lore creates the impression that the whole stories are units and that their cohesion is strong, the whole complex very old. The analysis of American material, on the other hand, demonstrates that complex stories are new, that there is little cohesion between the component elements, and that the really old parts of tales are the incidents and a few simple plots." There is a tendency among these Indian tales to shake off many of their supernatural elements along the border of their area of distribution, but this is "counterbalanced by another tendency of tales to take on new supernatural significance." In conclusion Professor Boas has a word to say (pages 879-881) regarding the general theory of mythology, with particular reference to that widespread impression that mythic tales represent an attempt on the part of primitive man to explain the phenomena of nature. Professor Boas thinks that this belief is not justified. His conclusion is that the material presented in this work "rather emphasizes the fact that its origin must be looked for in the imaginative tales dealing with the social life of the people." Still he would probably not deny that particular applications of such tales to the explanation of natural phenomena had been attempted at a very remote period in human history.

"Tsimshian Mythology" furnishes a notable addition to the sum of myth material and to our knowledge of northwest coast enthnology, but its chief claim to distinction rests on the great advance which it registers in the comparative study of myths current among American Indians and in the interpretation of them.

JOHN R. SWANTON

SMITHSONIAN INSTITUTION,
WASHINGTON, D. C.

The Genus Phoradendron. By WILLIAM TRELEASE, Professor of Botany in the University of Illinois. Published by the University. Octavo, pp. 224, pls. 245. Price, paper, $2.00; cloth, $2.50.

It is fortunate for botanists that the author of this excellent treatise has made so thorough a revision of the genus *Phoradendron* instead of being content with merely attempting to straighten out the tangle existing in regard to the group of related forms hitherto known as *Phoradendron flavescens*, as he first contemplated. The author notes that Engelmann has shown too great a conservatism in his published studies of the various forms of species of the genus, by later withdrawing segregates of *P. flavescens* that he formerly had recognized, and that in continuing the work of Engelmann, also being influenced by his views, Torrey allowed a number of forms which he had designated as new species to lie unpublished in the Torrey herbarium. The author in addition to making a critical study of the abundant data and material of North American species collected by Engelmann, Torrey and others in the great herbaria of this country, visited those of Europe and extended the investigation to the collection of West Indian and South American species by Urban, Martins and others. This has enabled him to make a careful comparison of numerous types and variants of species of the genus, and to more carefully discriminate between varieties and species He recognizes 262 differentiable forms, most of which he has classified as species. In this matter he apparently does not share the conservatism of Engelmann and Torrey. Of the species he now recognizes, 154 are listed from North America and 124 from South America. The genus is separated into two primary groups, the Boreales and the Æquatoriales, plants of the former are constantly without, and the latter constantly with cataphyls on their foliage shoots. Both groups contain species destitute of expanded foliage, which are well represented by *Phoradendron juniperinum* in the southwestern United States. All of our species belong to the Boreales, those of Mexico and Central America to both primary groups, and those of the West Indies and South America wholly to the Æquatoriales. These primary groups are each divided and then subdivided, making finally in all groups 55 minor subdivisions.

The book contains 224 pages of descriptive matter including very good and usable keys; these are supplemented by indexes of collectors, occurrence, and names. The illustrations, 245 full sized plates, are indeed works of art but are also true to nature. Few books of this class are so fully and beautifully illustrated.

GEORGE G. HEDGCOCK

MECHANICAL PROPERTIES OF WOOD DETERMINED

A NUMBER of fundamental laws governing the properties of wood, such as those covering the relations between strength and specific gravity, and between strength and moisture content, are laid down in a bulletin just issued by the Department of Agriculture. In this publication are presented the results of about 130,000 strength tests, probably the largest single series ever run on one material, made by the Forest Products Laboratory of the Forest Service on 126 species of American woods. The laws derived from the tests cover the general relations existing between mechanical and physical properties of each species, and also the general relations existing between these properties irrespective of species.

The results ought to prove of great value wherever knowledge of the properties of wood is essential. They have, for example, made possible the preparation of accurate tables showing all the needed strength properties for the woods used in airplanes. With these as a basis, specifications can be drawn up to eliminate all material that does not meet the exacting requirements of this highly specialized use.

The data also permit of the proper choice of substitutes for woods which have become scarce or unobtainable. Here again the airplane may be cited, since the supplies of some woods ordinarily used in airplane construction are insufficient to meet the present building program of the United States and its allies.

Among the relations between mechanical and physical properties of wood for which laws have been obtained are static bending-specific gravity, impact bending-specific gravity, compression parellel to grain-specific gravity, compression perpendicular to grain-specific gravity, static bending-moisture content; impact bending-moisture content, compression parallel to grain-moisture content, compression perpendicular to grain-moisture content, shrinkage-moisture content.

The bulletin, the authors of which are J. A. Newlin and Thomas R. C. Wilson, is entitled "Mechanical Properties of Woods Grown in the United States," and is No. 556 in the Department of Agriculture series.

SPECIAL ARTICLES

A CONVENIENT NERVE HOLDER

For several years past in this laboratory experiments on chemical stimulation have formed a part of the routine students' work on the physiology of muscle and nerve. In these experiments we have used a nerve holder which has proved so simple and convenient that it seems desirable to suggest it to others. In its first form it consisted merely of a thin watch-glass 45 to 50 mm. in diameter, cemented by sealing-wax to the flattened end of a piece of ¼ inch lead wire 12 inches long.

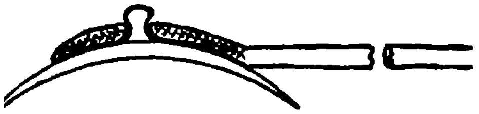

Fig. 1.

If the muscle of a gastrocnemius-sciatic preparation is mounted on a muscle lever, the edge of the watch-glass may be brought very near to the muscle and the whole nerve may be allowed to lie in the liquid to be applied, as for example, a solution of sodium citrate or barium chloride.

The construction is so simple, requiring no special skill and only a few minutes of time, that it was used in this way for two or three years. Later, Mr. L. A. Ray, technician, devised the following more permanent construction. A small bit of glass rod is fused to the bottom of the watch-glass. The rod is then melted and pulled in two at a point about ⅛ to ¼ inch from the bottom of the glass, and is held in the flame till a small knob forms on the end. A hole is punched in the flattened end of the lead rod, the glass rod is inserted and the joint made fast with cement. The knob on the end of the glass is held firmly in place by the cement. The accompanying figure of a section of watch-glass and rod will make the whole arrangement perfectly obvious.

S. S. Maxwell

Rudolph Spreckels Physiological Laboratory,
University of California

THE URINE OF THE HORNED LIZARD

Vauquelin,[1] in reporting the first analysis of reptilian urine, in 1822, stated that it was composed almost entirely of uric acid, and since that time this fact has been interpreted by various observers as an adaptation to the conditions of life in arid regions, where animals obtain their only external water supply in very limited quantities in the food substances, as this type of nitrogenous excretion involves practically no water loss. The reptiles of arid regions have been known for some time to excrete practically all of their waste nitrogen in the form of uric acid and its salts, while, on the other hand, birds and aquatic and semi-aquatic reptiles may excrete considerable amounts of urea.

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[1] Vauquelin, Louis Nicolas, "Examen des excrémens des serpens que l'on fait voir en ce moment à Paris, Rue Saint-Nicaise," *Annales de Chimie et de Phisique. 2me Serie*, Tome 21, p. 440, 1822. Two boas, species not stated, were the source of the urine examined in this case. Uric acid had also been associated with reptiles as early as 1792, when a "pasty deposit" found in the bladder of a tortoise by Vicq-d'Azyr was found to contain this substance.

The urine of the horned lizard is excreted in the dry form at the same time as the feces, from which it is separated by a constriction of the common mass, the material voided at any one time having roughly the shape of a dumbbell, one of the enlargements being composed of urine and the other of fecal matter. The following figures for the composition of the urine of *Phrynosoma cornutum* (specimens obtained at Alamogordo, N. M.) have been obtained recently in the laboratory of physiological chemistry of the University of Illinois, the work having been undertaken at the suggestion and under the direction of Dr. H. B. Lewis.

Constituents	Mg per Gm of Dry Urine
Total nitrogen	260
Urea + ammonia nitrogen	1.4
Ammonia nitrogen	1.4
Uric acid	765
Creatinine	Trace
Ash	87.5
Phosphorus as P_2O_5	3.5

It will be noticed from the above figures that uric acid accounts for practically the total amount of nitrogen present, and that there is no urea. The small amount of ammonia is probably present as ammonium urate. The ash present is mostly composed of foreign materials (sand grains, etc.) inseparable from the urinary mass and therefore weighed and analyzed with it.

A. O. Weese

The University of Illinois

SOCIETIES AND ACADEMIES

AMERICAN MATHEMATICAL SOCIETY

The one hundred and ninety-third regular meeting of the American Mathematical Society was held at Columbia University on Saturday, October 27. The attendance at the morning and afternoon sessions included thirty-five members. Professor Oswald Veblen occupied the chair, being relieved by Professor L. P. Eisenhart. The council announced the election of the following persons to membership in the society: Dr. J. V. DePorte, State College, Albany, N. Y.; Mr. J. W. Lasley, Jr., University of North Carolina; Mr. Vincente Mills, Philippine Bureau of Lands; Professor B. M. Woods, University of California. Five applications for membership were received.

A committee was appointed to audit the accounts of the treasurer for the current year. A list of nominations for officers and other members of the council was prepared and ordered printed on the official ballot for the annual election at the December meeting. The Secretary was directed to procure insurance to the amount of $10,000 on the library of the society, which is deposited in the Columbia Library.

The following papers were read at this meeting:

R. D. Carmichael: "Elementary inequalities for the roots of an algebraic equation."

Louise D. Cummings: "The two-column indices for triad systems on fifteen elements."

G. A. Pfeiffer: "On the continuous mapping of regions bounded by simple closed curves."

J. F. Ritt: "On the differentiability of asymptotic series."

W. B. Fite: "Concerning the zeros of the solutions of certain linear differential equations."

J. E. Rowe: "Hexagons related to any plane cubic curve."

G. D. Birkhoff: "On a theorem concerning closed normalized orthogonal sets of functions with an application to Sturm-Liouville series."

Edward Kasner: "Systems of circles related to the theory of heat."

O. E. Glenn: "Systems of invariants and covariants of Einstein's theory of relativity."

J. K. Whittemore: "Theorems on ruled surfaces."

R. L. Moore: "On certain systems of equally continuous curves."

R. L. Moore: "Continua that have no continua of condensation."

J. R. Kline: "Necessary and sufficient conditions, in terms of order, that it be possible to pass a simple continuous arc through a plane point set."

Oswald Veblen: "On the deformation of n-cells."

Oswald Veblen: "Deformations within an n-dimensional sphere."

The San Francisco Section met at the University of California on October 27. The Southwestern Section will meet at the University of Oklahoma on December 1. The Chicago Section will meet with the Mathematical Association of America at the University of Chicago on December 28–29. The annual meeting of the society will be held at Columbia University on December 27–28.

F. N. Cole,
Secretary

SCIENCE

FRIDAY, NOVEMBER 30, 1917

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THE PRODUCTION OF SCIENTIFIC KNOWLEDGE[1]

THE great value of scientific research both to the industries and to the nations at large is now generally recognized throughout the world and the last few years have seen a remarkable increase in the efforts made to stimulate the production of scientific knowledge. In 1914 the American Association for the Advancement of Science appointed a Committee of One Hundred to inquire into the steps which should be taken for the increase of scientific research in the United States and the work of this committee has been continued and expanded by the National Research Council. Among the European nations there is a great awakening to the national value of scientific research. The British government has appointed a Department of the Privy Council to deal with the subject, while it is announced that in France a new national laboratory on a very large scale has been projected. In Australia the government has appointed a special department to consider what steps should be taken for the organization and development of research work in the Commonwealth, and in Canada the matter has been the subject of government inquiry and solicitude.

The increase of scientific knowledge can be divided into three steps: first, the production of new knowledge by means of laboratory research; second, the publication of this knowledge in the form of papers and abstracts of papers; third, the digestion of the new knowledge and its absorption into the general mass of information by critical comparison with other experiments on the same or similar subjects. The whole process, in fact, may be likened to the process of thought. We have first the perception by means of the senses. The percept is then stored in the memory and in the mind is compared with other previously stored percepts, and finally forms with them a conception.

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[1] Being a paper read before the Rochester Section of the Optical Society of America, October 23, 1917.

I desire in this paper to consider the methods by which these three sections of the production of knowledge may be carried on, to suggest an arrangement of laboratories to produce experimental results dealing with any branch of science, then to consider how the knowledge so obtained may best be stored and classified and finally the methods to be employed to make the results of scientific research available for application.

1. RESEARCH WORK

The agencies engaged in scientific research are of several kinds. The traditional home of research work is in the university, and the bulk of the scientific production of the world comes from institutions connected with teaching. The industries are more and more supporting research laboratories, a large number of which contribute to the general fund of scientific knowledge by publishing the results which they obtain, and some of which are engaged upon purely scientific work of no mean order. Consulting and technical laboratories engaged in industrial work make frequent contributions to science, and there are some very important laboratories engaged in pure research work which are supported by philanthropic foundations.

The classification of research laboratories is not altogether an easy task. They may obviously be classified according to the source of the funds which support them; that is, we may classify them as university laboratories, industrial laboratories, government laboratories, institution laboratories, and so on, but if we look at them simply in the light of the research undertaken, this does not seem to be altogether a logical classification since there is little distinction between the work done in some university laboratories and some industrial laboratories, and the work of the government and institution laboratories again overlaps that of the two former classes.

The University of Pittsburgh, for instance, has an industrial laboratory where definitely technical problems are dealt with. The research work on photometry done at Nela Park and at Cornell University would seem to be similar in kind, and work on physical chemistry or on the structure of chemical compounds is of the same type, requires the same class of workers, and produces the same results, whether it be done in a university, in a laboratory of the Carnegie Institution or in such an industrial laboratory as that of the General Electric Company. It is equally difficult to classify laboratories according to the purpose for which researches are avowedly carried on. Most university laboratories are willing to undertake work of industrial value, and, indeed, some specialize in such problems; while many industrial laboratories are quite willing to carry out a research of purely academic and theoretical interest provided the problems involved bear a relation to the general work of the laboratory.

A useful classification of laboratories can, however, be obtained if we consider whether the problems investigated in a laboratory are all connected with one common subject or whether the problems are of many kinds, having no connecting bond of interest. I would suggest that the first type of laboratory might be called "convergent" laboratories and the second "divergent."'

In the "divergent" group of laboratories are included all those institutions where research is carried on which are interested in science in general or in science as applied to industry and which will attack any problem which may seem to promise progress in knowledge or, in the case of an industrial laboratory, financial return. Most university laboratories are of this type. When they devote themselves to special problems it is usually because of the predilection of some professor, and as a general rule a student or instructor may choose any problem in the whole field of the science in which he is working and may carry out an investigation on that problem if he be interested in it without regard to the relation of his work to the other work which is carried on in the same laboratory.

Correspondingly, in most industrial laboratories the problems investigated are those which present themselves as a result of factory experience or of suggestions from the men working in the laboratory and which promise financial return, and the different problems carried on in the same laboratory are not necessarily related in any way whatever.

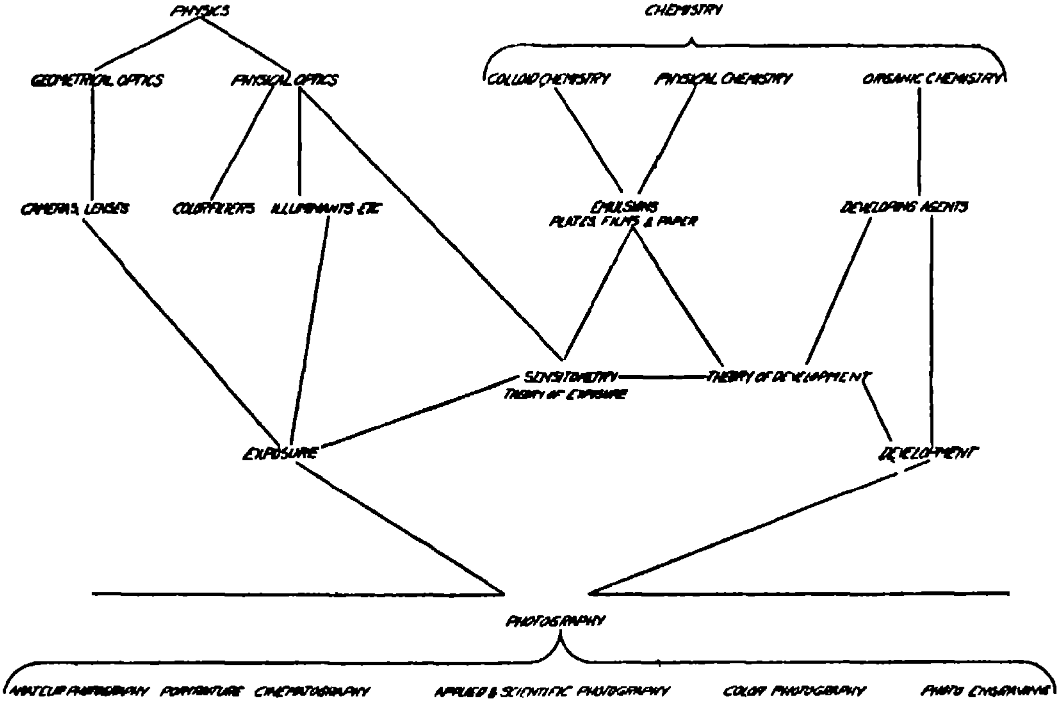
The greater number of university and industrial laboratories are necessarily of this type. It would be a disadvantage for a university laboratory, whose primary business is training students, to be too narrowly specialized. Specialized university laboratories are only desirable in the case of post-graduate students, and it would be very inadvisable to allow the laboratories responsible for the general training of scientific men to specialize in one branch of science, since as a result the students would acquire a proper acquaintance with only a limited portion of their subject.

Industrial laboratories, on the other hand, must necessarily be prepared to deal with any problems presented by the works, and as these will be of all kinds, covering generally the whole field of physics, chemistry and engineering, it is impossible for the usual works laboratory to specialize except in so far as it deals with the works processes themselves.

In the "convergent" laboratories, however, although the actual investigations may cover as great a range of science as those undertaken in a "divergent" laboratory, yet all those investigations are directed toward a common end; that is, towards the elucidation of associated problems related to one subject. Thus, the staff of the Geophysical Laboratory, which includes physicists, geologists, crystallographers, mineralogists and chemists, works on the structure of the rocks, and although the field of the actual investigations ranges from high temperature photometry to the physical chemistry of the phase rule, yet the results of all the work carried out are converged on the problem of the structure and the origin of the earth's crust.

The Nela Park Laboratory, in the same way, is studying the production, distribution and measurement of illumination, and all its work, which may involve physiology, physics and chemistry, is related to that one subject. Such convergent laboratories sometimes develop in universities owing to the intense interest of a professor in a single subject and to the enthusiasm which inspires students and assistants to collaborate with him and to concentrate all their energies on the same group of problems. There are many examples of such laboratories, such as the laboratories dealing with radio-activity, and those which are concerned chiefly with spectroscopy. Among others may be mentioned the Cavendish Laboratory at Cambridge and several of the larger university laboratories which deal with the physical chemistry of solutions.

But these university laboratories are rarely able to concentrate on to the group of problems which they are studying specialists from such different branches of science as are available for similar laboratories outside the universities owing to the fact that it is very difficult to obtain interdepartmental cooperation in research in a university. In a specialized laboratory, on the other hand, workers in all branches of science may well collaborate in the investigation of problems representing different points of view of one general subject.



In addition to the examples of industrial and institutional laboratories mentioned above I should like to illustrate the structure of a convergent laboratory, if I may be forgiven for doing so, by referring to the organization of the research laboratory with which I am connected—that of the Eastman Kodak Company.

The purpose of this laboratory is the investigation of the scientific foundations of photography and its applications, everything relating to photography in all its branches and applications being of interest. The branches of science which are of chief importance in photographic problems are those of optics in physics and of the colloidal, physical and organic branches of chemistry, and the relations of these sciences to photographic problems are shown in graphic form in Fig. 1.

Optics deals on its geometrical side with the materials used in photography—cameras, lenses, shutters, etc.—and on its physical side with such materials as color filters and illuminants, but especially with the study of the relation of the photographic image to the light by means of which it was produced—a study which is known by the name of sensitometry. The manufacture of the sensitive material itself, which in the case of modern photographic plates, films and paper is called the emulsion, is a province of colloid and physical chemistry, colloid chemistry dealing with the precipitation and nature of the sensitive silver salts formed in their gelatine layer, while physical chemistry informs us as to the nature of the reactions which go on, both in the formation of the sensitive substance and in its subsequent development after exposure.

The organic chemist prepares the reducing agents required for development and the dyes by which color sensitiveness is given to the photographic materials and by which the art of color photography can be carried on, and while the physicist therefore deals with sensitometry and the theory of exposure, the chemist must deal at the same time with the theory of development and with the conditions relating to the development of photographic images.

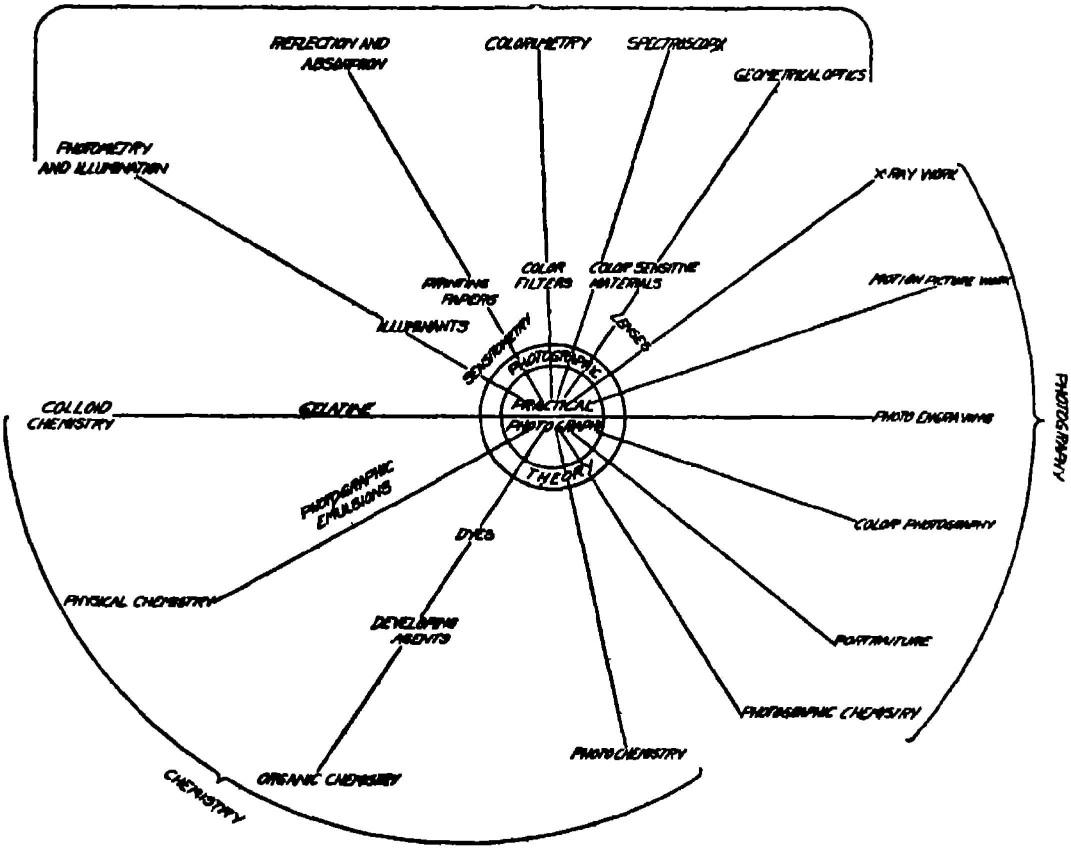


Fig. 2.

A laboratory, therefore, for the study of photographic problems must be arranged with a number of sections such as are shown in Fig. 2. In physics we require departments dealing with sensitometry and with illumination, reflection and absorption, colorimetry, spectroscopy and geometrical optics. We need a department of colloid chemistry, one of physical chemistry, one of organic chemistry, one of photo-chemistry to deal with the action of light upon the plate, and finally a number of photographic departments, dealing with photographic chemistry, with portraiture, color photography, photo-engraving, motion picture work and X-ray work, and all these departments are converged together first upon the theory, and then upon the practise, of photography.

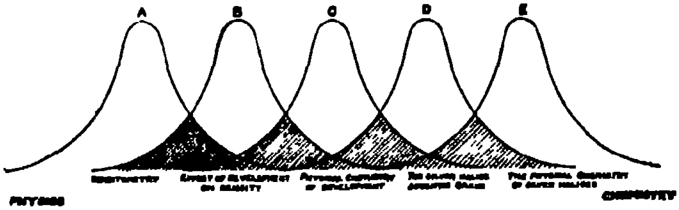

A
B
C
D
E
SENSITOMETRY
EFFECT OF DEVELOPMENT ON DENSITY
PHYSICAL CHEMISTRY OF DEVELOPMENT
THE PHYSICAL CHEMISTRY OF SILVER HALIDES
PHYSICS
CHEMISTRY

FIG. 3.

Each research specialist in the laboratory is given work corresponding to a limited field of science, so that while his special attention is devoted to that one department his field of activity just overlaps that of the departments on each side of him, while his general knowledge of the subject should, of course, cover a much wider range. It is important that each man should have his own special field of work and that overlapping should not be complete since such complete overlapping will inevitably produce friction destructive of cooperation and harmony. The way in which such a subdivision is arranged may perhaps be best illustrated by Fig. 3, which shows the range of the specific investigations of those who in our laboratory cover the range of research work between sensitometry and pure physical chemistry. There are five workers in this range; the first, *A*, being a pure physicist; *B*, a physicist with a considerable experience of chemistry; *C*, a physical chemist who has specialized in photography; *D*, a physical chemist who has specialized in photographic theory; and *E*, a pure physical chemist. The interest of each of these workers overlaps the field of the other workers but nevertheless each of them has his own specific problem, his own equipment and apparatus. Thus, *A* and *B* use sensitometric apparatus chiefly; *C*, both sensitometric apparatus and the thermostatic and electrical equipment of physical chemistry; *D*, microscopic apparatus and chemical apparatus dealing with the precipitation of silver salts; and *E*, the analytical and solubility apparatus of chemistry.

The whole of this range is also connected with colloid chemistry and especially the overlap of the different sections involves colloid problems, so that we can consider colloid chemistry as dealing with the interrelations of the different sections of photographic chemistry and can represent its province in the diagram by shading the overlapping areas. The colloid division of the laboratory will therefore be interested in the work of each of the specific investigators and will be of assistance to all of them.

These charts, prepared for a photographic laboratory, are equally applicable in form for almost any other convergent laboratory, so that if we have to work out the organization of a research-laboratory which is to study any inter-related group of problems, we can do it by the construction of charts similar to these. Thus, considering Fig. 1, we place first at the bottom of the chart the general subject considered and its various branches and then above these the scientific problems involved, separating out on opposite sides of the chart those problems which would involve different branches of pure science. Thus, we can place on one side biological problems, then physical problems, then chemical problems and so on, so reconstructing a chart similar to Chart 1 from the bottom up until at the top we have the various branches of pure science involved, subdividing these branches until each subdivision represents the work capable of being handled by one man in the laboratory.

It will now be possible to draw Fig. 2, showing on the circumference the different sections of the laboratory for which accommodation, apparatus and men must be provided and showing the relation of these sections to the problem as a whole, and having worked this out it is easy to find the amount of space and the number of men which will be required or which the funds available will allow for each part of the work.

Specialized laboratories may originate in various ways, but it seems clear that with an increasing total amount of research and with an increasing realization of the importance of research more laboratories will be developed and no doubt laboratories which originally were of the divergent type will with their growth tend to split into a linked group of convergent laboratories. Consider, for instance, a very large industrial research laboratory covering a wide field of research and dealing with many different types of problems. There are two types of organization possible to such a laboratory. It might be divided according to the branches of science in which the workers were proficient. It might have, for instance, chemical divisions, physical divisions, and so on, but if the groups of problems dealt with were reasonably permanent in their character it would more probably develop into a group of convergent laboratories in which men from different branches of science—chemists, physicists and so on—worked together (and probably even had their working places in proximity) because they were working on the same general problem. Any national laboratory which is developed for industrial research, for instance, should almost certainly be organized as a group of convergent laboratories rather than as a group of separate physical, chemical, engineering, etc., laboratories.

We may expect then that the general organization of scientific research will tend towards the production of numbers of specialized laboratories, each of which will be working on an inter-related group of problems and attacking it from various standpoints.

Some of the questions relating to the internal organization suitable for these convergent laboratories have already been discussed in a former paper[3] and I need only add here that the "conference" system described there as a method of actually carrying on the scientific work of the research laboratory has continued to prove quite satisfactory.

2. THE CLASSIFICATION OF SCIENTIFIC KNOWLEDGE

The work of the research laboratories is published by various methods in the form of scientific papers, and with the increasing amount of research done the number of technical journals is increasing steadily, so that the workers in most branches of science find it difficult to keep up adequately with the current literature and especially those who become interested in the light thrown upon their own problem by other branches of science find it a task of great magnitude to acquaint themselves adequately with the literature. In order to meet this difficulty the various scientific societies publish journals giving abstracts in a conveniently indexed form of all the important papers published, and these abstract journals are of great value in searching for information on special subjects.

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[3] "The Organization of Industrial Scientific Research," SCIENCE, 1916, p. 763.

In spite of these abstract journals the task of obtaining all the references to the literature on a given subject is still a formidable one and might be very much simplified by the adoption of some radical changes in the organization of the abstraction and classification of scientific knowledge.

In the first place, there seems to be no reason why abstracts of scientific papers should be prepared by the national societies. At present, for instance, there are at least four complete sets of abstracts of chemical papers prepared in different countries, together with a number of less complete sets, and this represents a great overlapping and duplication of effort. On the other hand, sciences which have not so many or so wealthy workers as chemistry can not afford to produce any complete abstract journals, so that in these sciences reference to the literature is much more difficult. There seems to be no reason why an interchange of abstracts between different countries could not be arranged and, indeed, it might be the best method of obtaining abstracts to have the author of a paper supply an abstract suitable in form and length for the abstract journal at the same time that he sends his paper in to the journal which publishes it. The editor of that journal could suggest modifications in the abstract which in his opinion were desirable and forward both the corrected and uncorrected abstract to the editor of the abstract office, where it would be re-edited for insertion in the international abstract journals and these journals would, of course, be supported by subscriptions either through the societies or individuals in the same way as the abstract journals which are at present published.

Whether such an ambitious scheme of international scientific abstracts is capable of realization or not, reference to the abstract journals would be made much simpler if some method of numerical classification could be adopted.

In this connection, an experiment has been made in the last two years at the laboratory of the Eastman Kodak Company which has proved successful and which seems to be worth trying on a larger scale. The laboratory publishes each month for the use of the employees of the company an abstract bulletin of the photographic journals, including also abstracts from other scientific journals which have any relation to photographic problems or manufacture, the abstracts being made by the laboratory staff, and attached to each abstract is a reference number. These numbers refer to a numerical classification of photography based somewhat on a decimal system but adapted to the special needs of the subject. Each month as the bulletin is issued the abstracts are clipped out, pasted on cards and filed under the number printed on them in numerical order so that each recipient of the bulletin can prepare for himself a file either of all photographic literature or of any portion of it in which he may be specially interested. For example, in the classification photographic apparatus commences with the number "2," and if any particular worker is not interested in anything but apparatus, if he has no interest in materials or in photographic processes or in applications of photography, then he need only file the cards starting with "2," while, if his interests are even more limited, if, for instance, he is interested only in photographic shutters, he can file the cards starting with "262" thus obtaining only a very limited file which is, however, complete for the subject in which his interest lies.

If the abstract journals would print such a numerical classification attached to each abstract, adopting as their basis either the numerical classifications of the international catalogue of scientific literature, which have proved themselves satisfactory after trial, or some different classification adopted after due consideration, then each recipient of the abstract journals could prepare for himself card index files of the scientific literature in which he was interested.

To prepare a card index of all science or even a complete index of one large branch of science in this way would be too formidable an undertaking either for an individual or even for a small library, but it should certainly be possible for large libraries such as those of the scientific societies or of large cities to keep such numerically indexed files to which reference could be made by correspondence from any research worker. Thus, adopting the classification of the international catalogue, a worker who became interested in questions, *e. g.*, of catalysis, could apply for a copy of the reference cards on this subject, which would include all those indexed under 7065 and could be supplied with a complete file or with a partial file covering any period of time; the copies could easily be made by photographing the cards with such a camera as the "Photostat."

3. THE UTILIZATION OF SCIENTIFIC KNOWLEDGE

The actual application of science to industry is so vast a subject that it can not be considered here, but it is not satisfactory to leave the results of research at the point where they are published in papers and filed in the abstract journals. In order to make them available as a part of scientific knowledge the new information as it is obtained must be incorporated in books.

There are three classes of books dealing with scientific work which require separate consideration. The first class comprises the dictionaries, in which almost all the progress in some branches of science can conveniently be summarized. Beilstein's "Handbook of Organic Chemistry" is a good example of the way in which almost all the facts of a science can be absorbed in a classified form and made available for ready reference. These dictionaries, in fact, represent the critical and discriminating summary of the scientific publications on the subjects with which they deal and the preparation of such dictionaries should be ensured by international cooperation of the national societies.

Other sciences, however, do not by their nature lend themselves to the convenient preparation of dictionaries and what is wanted in this case are critical and well arranged handbooks covering the whole science and resuming impartially but critically the various additions which are made from time to time in the different branches of the subject. These handbooks as well as the dictionaries would, of course, require the addition of supplementary volumes from time to time and occasional complete revision.

The preparation of both dictionaries and handbooks would, of course, be greatly facilitated by the existence of a numerically classified card index to the literature concerned, and the preparation and revision of such books might well be undertaken in connection with the large libraries having in their possession the complete classified card indexes.

On the other hand, for the assistance of advanced students of science, what is required is a steady supply of monographs correlating critically and comprehensively all the literature in a special field, and these must be brought up-to-date from time to time. Such monographs are especially required in connection with rapidly developing new branches of science; it is difficult to overestimate the importance and value for progress in research of such a book as Bragg's "X-Rays and Crystal Structure" for instance, and while nothing should be done to hinder individual initiative in publishing such books, it would seem that when it was apparent that some branch of science required such a monograph a national society might very well approach well-known workers in the field and request them to write such a book, offering its assistance in the matter of bibliography and also offering to arrange for the publication of the manuscript. The initiative in indicating the need for such a book might come in the form of suggestions from members of the society or other scientific men. It is quite true that at the present time the scientific publishers are extremely active in searching for suitable books to publish, but necessarily they must consider the probable demand rather than the actual need for a book, and this leads to an over-production of books dealing with those fields of science which have a large following and an insufficient supply of books in those fields where the workers are few, though for progress the more sparsely worked fields would seem to require almost as much representation in literature as those which are of wider interest.

C. E. KENNETH MEES
RESEARCH LABORATORY,
EASTMAN KODAK COMPANY,
ROCHESTER, N. Y.,
October 26, 1917

THE DEPARTMENT OF AGRICULTURE AND THE FOOD SITUATION[1]

ACCORDING to the calendar it is almost a year to the day since my last meeting with you. Judged by the experiences through which we have passed, it seems more like a generation. Then this country was at peace, though its patience was being sorely tried. Now it is at war for reasons which I need not discuss before this body. It had no alternative. It either had to fight or to admit that it had no honor, was not a free nation, and would henceforth be subjected to a medieval power that in the last analysis knows no law but might. The nation was living on a peace basis and was not fully prepared for war in any respect; but it was fortunately circumstanced in the character of its agricultural organization and the number and efficiency of its expert agencies.

The nation may well pride itself on the fact that it had had the foresight generations ago to lay deep its agricultural foundations. I congratulate the representatives of the land grant colleges on the fine opportunity for service presented to them and on the splendid way in which they have seized it. The Department of Agriculture has had great comfort in the thought that these institutions, ably planned and wisely directed, existed in every part of the nation and stood ready not only to place themselves at the service of the national government but also to take the initiative in a vast number of directions.

When a state of war was declared on April 6, the food situation was unsatisfactory. The need of action was urgent and the appeal for direction was insistent. The nation looked for guidance primarily to the federal department and to the state agencies which it had so liberally supported for many generations. It was not disappointed. In a two-days' session at St. Louis, the trained agricultural officers of the country conceived and devised a program of legislation, organization and practise the essential features of which have not been successfully questioned and the substantial part of which has been enacted into law and set in operation. This great democracy revealed its inherent strength.

To the normal forces of the government leading with agriculture and rural problems there has been added an emergency agency with great and unusual powers, with enormous possibilities for good, and with a remarkable record for achievements already to its credit. It has enlisted in its ranks men of wide experience, fine spirit, and high ideals, many of whom are gladly volunteering their services for the common cause. I refer to the Food Administration under the direction of Mr. Hoover.

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[1] From an address given by Secretary of Agriculture Houston, addressing the Thirty-first Annual Convention of the Association of American Agricultural Colleges and Experimental Stations in Washington on November 14.

The relation between this agency and the other organized agricultural forces of the nation is intimate and fundamental. It is impossible completely to disassociate them and it would be undesirable to do so.

The problem in part is a common one, and it is of the first importance that the work be done in the closest cooperation and with an eye single for the public good. There is no need for undue duplication of effort and no causes of friction which can not be removed through an intelligent conception by each agency of the powers and purposes of all and by a spirit of mutual accommodation. In a broad way it is agreed that the prime function of the Department of Agriculture shall be the stimulation of production, the conservation of products on the farm through all the normal and approved processes, the promotion of better marketing and distribution of products from the farms to the markets, the prosecution of the work in home economics along usual lines, the dissemination of information, and the extension of all these activities as authorized by law. In a similar way the principal function of the Food Administration is the control and regulation of commercial distribution of foods; that is, of products which have reached the markets, are in the channels of distribution or in the hands of consumers, their conservation by consumers, the elimination of waste, and the handling of foods and feeds in the market by legal means through its regular officials as well as through its volunteer agencies.

In the main the Department of Agriculture deals with all the processes of farming up to the time products reach the market until they are in the requisite form for consumption and are available for the purpose. At this point the Food Administration enters and exercises its wide powers of regulation, direction, and suggestion. Where the Food Administration through its powers can be of assistance to the Deparament of Agriculture in its field, it is at liberty freely to make suggestion, and, when necessary, to cooperate in execution; and the same relation obtains as to the department's participation in Food Administration matters in which it has a vital interest and toward the promotion of which it can be of assistance. This is the substance of the agreement originally entered into between the Food Administration and the Department of Agriculture, and will be more satisfactorily observed as the agents and divisions of the two departments familiarize themselves more fully with their tasks and with the prescribed lines of effort.

Obviously the making of a program for the agricultural activities of the nation did not end with the St. Louis conference. Thought, action, and cooperation between the members of this association and other state agencies on the one hand and the federal department on the other have been continuous. Attention has been given without cessation to problems in the field of labor. It was obvious that difficulties would be presented and that apprehension would run beyond the actual condition. An army could not be raised without taking men from every field of activity; and it would have been unfair to any class of workers in the community to have proposed its exemption. It was impossible in the haste of the first draft satisfactorily to work out in detail the principle of selective service; but, nevertheless, under the regulations, consideration was given throughout by exemption boards and by the officers of the War Department to the needs of agriculture. With ampler time at its disposal, the War Department has worked out a system of classification which gives due regard to the necessity of retaining skilled farmers and expert agricultural leaders on the farms and ranches and in the educational and administrative services.

THE PITTSBURGH MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The opening session will be held on Thursday evening at 8 o'clock in the Carnegie Music Hall. After general announcements concerning the Convocation Week meetings, the retiring president of the Association, Dr. Charles R. Van Hise, will deliver his address on "The economic effects of the world war in the United States." Following the president's address, a reception will be tendered to the members of the association and the affiliated societies in the foyer of the Music Hall.

The addresses of the retiring vice-presidents, to be delivered throughout the week, are as follows:

Section A. Luther P. Eisenhart The Kinematical Generation of Surfaces.

Section B. Henry A. Bumstead. Present Tendencies in Theoretical Physics.

Section C. Julius Stieglitz. The Electron Theory of Valence and its Application to Problems of Inorganic and Organic Chemistry.

Section D. Henry M. Howe. Some Needs of Engineering.

Section E. Rollin D. Salisbury. The Educational Value of Geology.

Section F. George H. Parker. An Underlying Principle in the Architecture of the Nervous System.

Section G. C. Stuart Gager. The Near Future of Botany in America.

Section H. Frederick W. Hodge. The Ancient Pueblo of Hawikuh

Section I. Louis I. Dublin. The Significance of our Declining Birth Rate.

Section K. Edwin O. Jordan. Food-borne Infections.

Section L. (Leonard P. Ayres absent—no address.)

Section M. Whitman H. Jordan. The Future of Agricultural Education and Research in the United States.

The symposia, as far as announced, are as follows:

Section F. The Value of Zoology to Humanity.

Section E. Mineral Resources and Chemical Industries.

Section H. The Contributions of Psychology to the War.

Section G. Forestry Problems after the War, and War Work of the Botanical Committee of the Council of National Research.

Section I. Economic Problems based upon the World War.

Section K. The Food Problem of to-day (or the Lessons of the War in Medicine).

Section B. The Relationship of Physics to the War. (In cooperation with the Council of National Defense.)

The Council will meet daily at 9 A.M., at the Schenley Hotel, which will be the hotel headquarters.

Owing to the unprecedented demand for railroad service for the nation's defense, preferential rates for individual travel have been tentatively abandoned. The *New England Passenger Association,* however, has authorized local fares in each direction to its boundary points going and returning via same route only and over which one-way tickets are regularly sold—one and one half westbound differentials to apply, added to fares tendered. The *Trunk-Line Association* has authorized the following: "Two cents a mile in each direction, with minimum of $1 for the round trip, going and returning via same route only; tickets to be sold and good, going, December 26 to 28, and returning to reach original starting point not later than January 5, 1918." All members living beyond the boundaries of the above passenger association territories should consult their local passenger ticket agents. Members from west of the Mississippi should consult their local ticket agents for trans-continental and winter tourist rates.

The following affiliated societies have indicated their intention to meet in Pittsburgh during Convocation Week:

American Federation of Teachers of the Mathematical and the Natural Sciences.—Will hold council meeting on Saturday, December 29, 1917, 10 A.M. President, C. Riborg Mann. Secretary, William A. Hedrick, Central High School, Washington, D. C.

American Physical Society.—Will hold meetings on Thursday, Friday and Saturday, December 27 to 29, 1917, in joint session with Section B, A.A.A.S. President, R. A. Millikan. Secretary, Alfred D. Cole, Ohio State University, Columbus, Ohio.

Optical Society of America.—Will meet on Monday, December 31, 1917. President, Perley G. Nutting, Westinghouse Research Laboratory, East Pittsburgh, Pa.

American Electrochemical Society.—The Pittsburgh Section will meet on either Saturday, December 29, 1917, or Wednesday, January 2, 1918. President, Colin G. Fink. Secretary, Pittsburgh Section, C. G. Schleuderberg, East Pittsburgh, Pa.

Society for the Promotion of Engineering Education.—Will hold meetings on dates to be announced. President Milo S. Ketcham. Secretary, F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

Illuminating Engineering Society.—Will hold meetings on dates to be announced. President, G. H. Stickney. Chairman, Committee on Reciprocal Relations, W. A. Durgin, 72 West Adams St., Chicago, Ill.

Paleontological Society of America.—Will meet on Monday to Wednesday, December 31, 1917, to January 2, 1918. President, John C. Merriam Secretary, R. S. Bassler, U. S. National Museum, Washington, D. C.

Seismological Society of America.—Will meet on dates to be announced. President, J. B. Woodworth. Secretary, S. D. Townley, Stanford University, Cal.

American Society of Naturalists.—Will meet on Tuesday and Wednesday, January 1 and 2, 1918. President, George H. Shull. Secretary, Bradley M. Davis, University of Pennsylvania, Philadelphia, Pa.

Entomological Society of America.—Will meet on Friday and Saturday, December 28 and 29, 1917. President, Lawrence Bruner. Secretary, J. M. Aldrich, U. S. Bureau of Entomology, West Lafayette, Ind.

American Association of Economic Entomologists.—Will meet Monday to Wednesday, December 31, 1917, to January 2, 1918. President, R. A. Cooley. Secretary, Albert F. Burgess, Melrose Highlands, Mass.

Ecological Society of America.—Will meet Saturday, Monday and Tuesday, December 29, 31, 1917, and January 1, 1918. President, Ellsworth Huntington. Secretary, Forrest Shreve, Easton, Maryland.

American Nature-Study Society.—Will meet on dates to be announced. Secretary, Mrs. Anna B. Comstock, Cornell University, Ithaca, N. Y.

Wilson Ornithological Club.—Will meet on Tuesday and Wednesday, January 1 and 2, 1918. President, W. F. Henninger. Acting Secretary, T. C. Stephens, Morningside College, Sioux City, Iowa.

Botanical Society of America.—Will meet on Friday, Saturday, Monday and Tuesday, December 28, 29 and 31, 1917, and January 1. President, F. C. Newcombe. Secretary, H. H. Bartlett, University of Michigan, Ann Arbor, Mich.

American Phytopathological Society.—Will meet Friday to Wednesday, December 28, 1917, to January 2, 1918. President, Mel T. Cook. Secretary, C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

Society for Horticultural Science.—Will meet Thursday to Saturday, December 27 to 29, 1917. President, T. C. Johnson. Secretary, C. P. Close, College Park, Maryland.

American Microscopical Society.—Will hold meetings on Saturday, December 29, 1917, for transaction of business only. President, M. F. Guyer. Secretary, T. W. Galloway, Beloit College, Beloit, Wis.

American Fern Society.—Will meet on dates to be announced. President, William Palmer. Secretary, C. A. Weatherby, 1062 Main St., East Hartford, Conn.

American Psychological Association.—Will meet on Thursday to Saturday, December 27 to 29, 1917, President, R. M. Yerkes. Secretary, H. S. Langfeld, Harvard University, Cambridge, Mass.

American Metric Association.—Will meet on dates to be announced. President, George Frederick Kunz. Secretary, Howard Richards, Jr., 156 5th Avenue, New York, N. Y.

Society of American Foresters.—Will meet on dates to be announced. President, Filibert Roth. Secretary, Elmer R. Hodson, U. S. Forest Service, Washington, D. C.

School Garden Association of America.—Will meet on Monday, December 31, 1917. President, Evrie Kilpatrick, 124 West 30th Street, New York, N. Y.

Society of the Sigma Xi.—Will meet on Saturday, December 29, 1917. President, Julius Stieglitz. Secretary, Henry B. Ward, University of Illinois, Urbana, Ill.

Gamma Alpha Graduate Scientific Fraternity.—Will hold annual convention and dinner on date to be announced. President, Norman E. Gilbert, Dartmouth College, Hanover, N. H.

Phi Kappa Phi Fraternity.—Will meet on Saturday, December 29, 1917. President General, Edwin E. Sparks. Secretary General, L. H. Pammel, Iowa State College, Ames, Iowa.

Gamma Sigma Delta.—Will meet on dates to be announced. President, A. V. Storm. Secretary, L. H. Pammel, Iowa State College, Ames, Iowa.

SCIENTIFIC EVENTS

SMITHSONIAN EXCAVATIONS IN NEW MEXICO

AN expedition organized by the Bureau of American Ethnology of the Smithsonian Institution and the Museum of the American Indian, Heye Foundation of New York City, under the immediate direction of Mr. F. W. Hodge, ethnologist-in-charge of the Bureau mentioned has concluded its first season of excavating among the ruins of Hawikuh in western New Mexico. This pueblo was one of the famed "Seven Cities of Cibola" which was seen by Marcos de Niza, a Franciscan Friar, in 1539 and was the scene of the death of his negro guide and companion. In the following year the pueblo was stormed by Francisco Vasquez Coronado, the celebrated Spanish explorer, who almost lost his life in the attack. The Zuni occupants of Hawikuh fled to their stronghold a few miles away; the Spanish took possession of their village, which Coronado called Grenada, and while there wrote his report to the Viceroy of Mexico, giving an account of his expedition up to that time and sending various products of the country and examples of native art.

The excavations were commenced at the close of May by Mr. Hodge, assisted by Mr. Alanson Skinner and Mr. E. F. Coffin of the Museum of the American Indian. Work was begun in a great refuse heap forming the western slope of the elevation on which Hawikuh is situated. This refuse was found to contain many burials of Zuni dead, of which there were three types—remains cremated and deposited in cinerary vessels accompanied by food and water vessels; others buried at length, or in abnormal postures without accompaniments; and usually dismembered; others still deposited at length with head directed eastward and with them numerous vessels of earthenware, great quantities of food, and the personal tools and ornaments of the deceased. In all, 237 graves were opened during the three months devoted to the work, in which quantities of pottery vessels of various forms and with a great range of decorative painting, were uncovered. Among burials of the third type mentioned were several skeletons of members of the Zuni Priesthood of the Bow, with their war paraphernalia, including bows and arrows, sacred paint, war clubs, and their personal or ceremonial belongings.

A Franciscan mission was established at Hawikuh in 1639 and continued in operation until 1670 when the pueblo was abandoned on account of Apache depredations. Considering the length of time since the village was forsaken by its inhabitants, the remains were in a remarkably good state of preservation. The deposit of great quantities of food in the graves, especially boiled corn on the cob, had the effect of decaying the bones but of preserving the materials that usually more readily perish, such as baskets, fabrics, and objects of wood, many of which were saved by immediate treatment. Many very beautiful things found in association with the remains include 8 objects of turquoise mosaic, consisting of ornamental hair combs, ear pendants, and hair ornaments, some of which are so well executed as to be among the finest examples of encrusted turquoise ever found in America, and far exceeding the mosaic work of the Hopi Indians in Arizona to-day. Of the fabrics various examples were recovered, and indeed in one instance the clothing of a woman was so well preserved that it was possible to study the character of her dress from neck to feet.

The pottery of the Hawikuh people, as mentioned, possesses a wide range of decoration and coloring. Most of the designs are geometric, but numerous highly conventionalized figures of birds, as well as many lifelike forms of quadrupeds, the eagle, the butterfly, the tadpole, and the corn plant were found. Many of the vessels are decorated with a distinct glaze, black and green predominating. The vessels consist chiefly of bowls, ranging in size from tiny toy affairs to some as large as fifteen inches in diameter; but there are also large and small water jars, and black, undecorated cooking pots, duck-shaped vessels, and the like.

The finds include, among others, the ceremonial paraphernalia of a medicine man, comprising his medicines; a turkey's egg containing the bones of the embryo and accompanied with a food bowl; several skeletons of eagles, turkeys, and dogs that had been ceremonially buried, and deposits of pottery that had been broken in sacrifice and deposited in the cemetery not as burial accompaniments. It was the custom of the Zunis of Hawikuh to "kill" all the vessels deposited with their dead by throwing them into the graves, and this was likewise the case with other household utensils such as metates and manos used in grinding corn. Some of the vessels escaped injury, while all of the fragments of the broken ones were carefully gathered and will be repaired.

The site of Hawikuh covers an area of about 750 by 850 feet, so that only a comparatively small part of the site was excavated during this season. The refuse was found to attain a depth of 14½ feet in the western slope and it will probably be found to reach a depth of at least 18 feet before the walls of the summit of the elevation are reached. An interesting discovery consists of the remains of many walls entirely beneath this great deposit of refuse, showing that the site was occupied in prehistoric times long before Hawikuh itself was built.

PROGRESS IN COMBATING HOOKWORM

THE recently published annual report of the Rockefeller Foundation records the results of intensive work on the study and control of hookworm and malaria. The report as quoted in the *Boston Medical and Surgical Journal* states that during the year 1916 the work of the International Health Board continued to be directed chiefly toward the relief and control of hookworm disease. In coöperation with the government, systematic efforts toward control have now been inaugurated in eight of the Southern states and in fifteen foreign countries, located between degrees of latitude 36 north and 30 south in the tropical and sub-tropical belt, which is the native habitat of the hookworm. New fields of operations in 1916 were Salvador, Brazil, Ceylon, and Siam. Arrangements were also completed to start work early in 1917 in the Fiji Islands, in Papua, and in Queensland, Australia.

In British Honduras and the island of Barbados, preliminary infection surveys were made, and in the Yangtsekiang valley of Central China a preliminary survey was carried out with special reference to the problem of soil pollution in shallow mining operations.

The board conducted during the year a series of four experiments in malaria control. Three were finished. The fourth will be completed in 1917. The object of all four experiments was to determine the degree to which malaria could be controlled within the limits of reasonable expenditure and under conditions prevailing in typical farm communities of the South. Gratifying results have been obtained.

Two commissions were sent to South America. One, composed of six sanitarians, with Maj.-Gen. William C. Gorgas as chairman, visited the republics of Ecuador, Peru, Colombia, Venezuela and Brazil, to study yellow fever conditions. Two definite objects were sought: (1) to determine the status of doubtful endemic centers of infection; (2) to ascertain what measures were necessary and feasible to eradicate the disease from the localities responsible for its dissemination. The second commission investigated medical education and public health agencies in Brazil.

Active measures to control and prevent hookworm disease are now in operation in Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Texas and Virginia; in Antigua, Grenada. St. Lucia, St. Vincent and Trinidad of the West Indies; in British Guiana and Dutch Guiana; in Costa Rica, Guatemala, Nicaragua, Panama and Salvador of Central America; in

Brazil, and in Ceylon and Siam of the Far East.

Four experiments in malaria control were carried out during 1916 at different points in the Lower Mississippi River Valley. In each a different line of investigation was pursued, the object being to discover a practical method of control which the average rural community could afford.

An experiment was conducted under the administration of the Mississippi Department of Health, with Dr. W. S. Leathers as administrative director and Dr. C. C. Bass of Tulane University as scientific director. The practicability of control through detecting the carriers and freeing them of the malaria parasites was tested. The experiment covered 225 square miles of territory, the size of the communities varying from nine to sixteen square miles, with an average population of 1,000. Adjoining communities were taken up, one after another, as facilities permitted, the work in each lasting about four weeks with subsequent visits to insure thoroughness. Blood tests were taken, quinine treatment was given to those found infected. The experiment will be continued in 1917.

THE BRITISH COMMITTEE FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

THE second annual report of the Committee of the Privy Council for Scientific and Industrial Research for the year 1916–17 has been published. According to an article in *Nature* it consists of an introductory statement by Lord Curzon, as lord president of the privy council, the report of the Advisory Council, signed by Sir William McCormick and Sir Frank Health, and appendices giving orders in council, terms of the imperial trust, documents relating to research associations, and names of members of committees attached to the department of scientific and industrial research. Lord Curzon points out in his introduction that the foundation of the department led to the creation of the imperial trust for the encouragement of scientific and industrial research.

The trust holds on behalf of the department the sum of one million sterling which Parliament has voted for the purposes of the department. The negotiations of the advisory council with the leading manufacturers in the various industries showed that it would not be possible to develop systematic research on a large scale unless the government were in the position to assist financially over an agreed period of years. These considerations led the government to place a fund at the disposal of the privy council committee to be spent over a period of five or six years afforded the best means of dealing with the problem. During the past year negotiations have been concluded with the Royal Society for the transfer of the property of the National Physical Laboratory, together with the responsibility for its maintenance and development, to the department of scientific and industrial research. The scientific management of the laboratory will remain in the hands of the executive committee under the chairmanship of Lord Rayleigh, a member of the advisory council.

The committee reported last year that grants had been approved to a number of individual students and research workers for the year 1916–17 to an amount not exceeding 6000*l.* The amount actually expended under this head, however, was not more than 3550*l.* upon thirty-six workers. Throughout the work has suffered in amount owing to the war, and the committee was unable to expend more than 14,524*l.* out of the 40,000*l.* placed at its disposal by Parliament for the financial year 1916–17. During the current year a sum of 38,050*l.* was taken in the estimates, in addition to the fund of a million referred to already. The annual vote is intended to cover (*a*) the cost of those researches which will not be undertaken by the proposed research associations; (*b*) the grants to individual research workers, both students and others; and (*c*) the cost of administration.

The report says:

> The one question of policy, to which throughout the year we have continuously devoted our attention, is the working out, with all the care and advice we have been able to command, of the policy of cooperative industrial research foreshadowed in our last report. Lord Crewe, who was at that

time lord president of the privy council, received a deputation of the board of scientific societies on December 1 last, at which he outlined the policy of the government in regard to industrial research. He announced their intention to ask parliament to place a large fund—a million sterling—at the disposal of the department to enable it to cooperate with the industries of the country in the foundation and maintenance of approved associations for research during the next five years or so. After these initial years it is expected that the larger industries, at any rate, will be able and willing to carry on the work of the associations without assistance. The intention of the government is to make a contribution to the assured income of such associations from the subscriptions of their members, varying in amount according to circumstances, and with a normal maximum of pound for pound, though in very exceptional cases this limit may be exceeded. Lord Crewe also announced that the board of inland revenue would be prepared to instruct surveyors of taxes to allow as a working expense for income-tax purposes the contributions by traders to industrial associations formed for the purpose of scientific research for the benefit of the various trades. The allowance would be subject to certain conditions; that is to say, the association must be under government supervision and the trader's contribution must be "an out and out payment, made from his trade profits and giving him no proprietary interest in the property of the association." Since this decision includes war profits and excess profits taxes, it offers a considerable inducement to firms affected by these taxes to act promptly.

A TRIBUTE TO PROFESSOR CHURCH

THE College of Civil Engineering of Cornell University paid a tribute of affection and respect to the emeritus professor of applied mechanics and hydraulics, Irving Porter Church, '73, on November 9. Alumni of the college presented to the university a portrait of Professor Church and the sum of $2,500 in Liberty Bonds to form the Irving P. Church Fund, the income of which is to be devoted to the purchase of additions to the library of the college.

According to the *Cornell Alumni News*, a simple ceremony of presentation took place at noon in the auditorium of Goldwin Smith Hall. Among the persons assembled were Mr. White and Professors Law, Hewett, Comstock, and Gage—men whose terms of service in the faculty are comparable in length to that of Professor Church; Mrs. Crandall; the members of the faculty of civil engineering, and a number of other professors.

On the rostrum, veiled, was the portrait lately completed by J. Campbell Phillips. Dean Haskell expressed the pleasure of the faculty of civil engineering in taking part in this tribute to a beloved teacher, and introduced William D. Kelley, '80, the representative of the alumni committee which the Cornell Society of Civil Engineers had appointed to provide the double memorial. Mr. Kelley gracefully expressed the affection of the old students for Professor Church and their sense of his great services to the college and to engineering science during so many years. The contributions to this testimonial, he said, had come from Cornell engineers in all parts of the world. He unveiled the portrait and presented it to the university. Then he took from his pocket the Liberty Bonds constituting the Church Fund and handed them to President Schurman.

The President accepted the gifts in behalf of the university. He congratulated the alumni of the College of Civil Engineering on the value of their testimonial and still more on the propriety of their gift. What other offering, he asked, could be more grateful to a teacher than this double memorial? The whole university, he said, would be forever in debt to Professor Church's character and scholarship.

Everybody arose as Professor Church advanced to the front of the platform. He apologized for his presence there. What need for him to talk, he said, when a speaking likeness was there to represent him. He accepted gratefully the tribute of his old students, and spoke for a few minutes of his reminiscences of the forty-eight years he had spent at Cornell.

The board of trustees next day adopted this resolution: "First, that the communication of Mr. F. W. Scheidenhelm, chairman of the committee, be spread on the minutes of this board; secondly, that the sincere thanks of the Trustees be tendered to the committee in charge and to all the Cornell men who have contributed to the gift for this admirable and appropriate tribute to Professor Church; and, thirdly, that it be referred to the dean of the college of civil engineering to hang the portrait in a suitable place."

SCIENTIFIC NOTES AND NEWS

Dr. Franklin P. Mall, professor of anatomy in the Johns Hopkins University and director of the department of embryology of the Carnegie Institution of Washington, died in Baltimore on November 17.

The anniversary address of the New York Academy of Medicine was delivered on November 15 by Dr. Henry Fairfield Osborn, L.L.D., president of the American Museum of National History, on "The origin and nature of life."

At its meeting held November 14 the Rumford Committee of the American Academy of Arts and Sciences voted the following appropriations: To Professor Raymond T. Birge, of Syracuse University, $150 in aid of his research on the Structure of Series Spectra; to Professor Theodore W. Richards, of Harvard University, $250 in aid of the publication of Marie's Tables of Physico-Chemical Data; to Professor Ancel St. John, $500 for the purchase of a refrigerating machine and accessories to be the property of the committee and loaned to Dr. St. John for use in connection with his researches on crystal structure by means of X-Rays.

Professor J. F. Kemp, for many years head of the department of geology in Columbia University, has become associated temporarily with the firm of Hager Bates and Lewis of Tulsa, Oklahoma, during the absence of Whitney Lewis in France.

Gustave R. Tuska, consulting engineer, New York City, formerly chief engineer of the Panama Railroad Company and lecturer in engineering at Columbia University, has been commissioned as major in the Engineer Section of the Officers' Reserve Corps of the United States Army.

Major John M. T. Finney, M. R. C., U. S. Army, has been appointed director of general surgery with the American Expeditionary Forces in France; Major Hugh H. Young, M. R. C., director of venereal skin and genitourinary surgery, and Lieutenant-Colonel Joseph Eiler, M. C., U. S. Army, director of the laboratory service.

It is announced that Dr. Hugh Cabot of British Base Hospital No. 22 has been made lieutenant colonel of the Royal English Medical Corps. He has succeeded Lieutenant-Colonel Sir Allan Perry as commanding officer of the hospital. This is in addition to being chief surgeon, which position he has held for some months.

Dr. A. B. Cordley, dean of agriculture and director of the Oregon Experiment Station, has been elected chairman of the State Lime Committee, authorized by the state legislature to build and operate a state-owned lime plant for providing cheap agricultural lime.

Dr. Caroline Rumbold, formerly collaborator in forest pathology, Bureau of Plant Industry, has been appointed assistant pathologist in the Office of Sugar Plant Investigations, Bureau of Plant Industry.

The sulphur committee of the War Industries Board has recently visited Texas. The committee consists of J. Parke Channing, J. W. Malcolmson, A. B. W. Hodges, P. S. Smith, of the U. S. Geological Survey, and W. O. Hotchkiss of the University of Wisconsin.

The course of popular scientific lectures of the California Academy of Sciences, Golden Gate Park, is being continued on Sunday afternoons in the Auditorium of the Museum in Golden Gate Park, as follows:

November 18. Professor G. A. Louderback, geology department, University of California, "A geological expedition into the interior of China." (Illustrated.)

November 25. Professor E. C. Franklin, chemistry department, Stanford University, "Liquid air." (With demonstrations.)

December 2. Dr. A. A. D'Ancona, member of San Francisco Board of Education, "Circulation of the blood." (Illustrated by motion pictures.)

December 9. Miss Alice Eastwood, curator, department of botany, California Academy of Sciences, "Weeds." (Illustrated.)

THE series of lectures on heredity presented before the Washington Academy of Sciences and later published in the *Journal* of the academy has now been reprinted in collected form. The volume contains the following addresses:

Dr. H. S. Jennings. "Observed changes in hereditary characters in relation to evolution."

Dr. Oscar Riddle. "The control of the sex ratio."

Dr. W. E. Castle. "The rôle of selection in heredity."

The collected papers bound in buckram in uniformity with the preceding series of lectures on "Nutrition" may be obtained from the treasurer of the academy, Mr. William Bowie, U. S. Coast Survey, Washington, D. C.

MR. CARLETON R. BALL, agronomist in charge of Western Wheat Investigations, U. S. Department of Agriculture, delivered a lecture on "The Scope and Problems of Agronomy" before the students in agronomy at the Maryland Agricultural College, on November 8.

THE American Phytopathological Society will meet at Pittsburgh, December 28, 1917, to January 3, 1918, in affiliation with the American Association for the Advancement of Science. There will be joint meetings of the society with Section G of the association and also with the Botanical Society of America.

SECTION E—Geology and Geography—of the American Association for the Advancement of Science, will hold meetings at Pittsburgh, Pa., on Friday and Saturday, December 28 and 29, with a session on Monday, December 31, provided enough papers are offered by geologists returning from the meetings of the Geological Society of America in St. Louis to make a Monday session desirable. A symposium upon the topic "Mineral Resources and Chemical Industry," to be held jointly with Section C, is planned for Friday, December 28. The address of the retiring vice-president of Section E, Professor Rollin D. Salisbury, of the University of Chicago, upon "The Educational Value of Geology," will be given on Saturday morning, December 29, at 10 o'clock. The meetings of Section E will be presided over by Professor George H. Perkins, of the University of Vermont. Titles of papers to be read before the Section should be in the hands of the secretary, Dr. Rollin T. Chamberlin, University of Chicago, before December 15. Members who can only attend a session on Monday, December 31, and who wish to present papers at that time are requested to notify the secretary as soon as pos-

THE *Journal of the American Medical Association* states that the second American orthopedic contingent, composed of forty-two medical officers under the direction of Major Goldthwaite, has arrived in England. All the officers as well as three of engineering experience commissioned in the sanitary corps are to take charge of the development of curative workshops in the American orthopedic hospitals in France. There are also twelve orthopedic nurses as a nucleus around which a nursing staff is to be developed. All the medical staff except the director are to be distributed temporarily through the British orthopedic centers. Arrangements have been made by which these centers can be used for training Americans in orthopedic work with the idea of providing relief for the large number of medical officers that will be required for this special work. When these men are needed for service in the American hospitals in France, another group will be sent from home to take their place in the British hospitals. The rotation will be continued until the American hospitals are fully staffed. Major Goldthwaite is going on to American headquarters in France to organize the orthopedic hospital with the American Army.

Before the Chemical Society, London, the following lectures will be given: December 6, "The Relation between Chemical Constitution and Physiological Action," Dr. F. L. Pyman; February 21, 1918, "Recent Studies on Active Nitrogen," Professor the Hon. R. J. Strutt; April 18, the Hugo Müller lecture, entitled "The Old and the New Mineralogy," Sir Henry A. Miers.

Dr. Richard Weil, professor of Experimental Medicine in Cornell Medical College, a major in the Medical Reserve Corps and chief of the medical staff of the Base Hospital at Camp Wheeler, Macon, Ga., died of pneumonia on November 19.

Nature states that in a private letter Dr. Paul Bertrand announces the death of his father, Professor C. E. Bertrand, the distinguished plant-anatomist and paleobotanist Dr. Bertrand was professor of botany at Lille, and lived there for the last three years of his life under German rule. Under these difficult conditions, he was still able to carry on both his university courses and his private research, as long as his health permitted.

The death is announced, on October 27, of Mr. Worthington G. Smith, of Dunstable, fellow of the Linnean Society, at eighty-two years of age and on October 24, at fifty-four years of age, of Mr. George T. Holloway, vice-president of the Institution of Mining and Metallurgy, known as a consultant metallurgist and assayer.

Mr. George Charles Crick, assistant in the geological department of the British Museum, died on October 8, aged sixty-one years.

EDUCATIONAL NOTES AND NEWS

The Probate Court has allowed the will of Mrs. Augusta E. Corbin, by the terms of which Boston University receives $555,000.

Extensive additions are to be made to the laboratories of the department of chemistry of the Rensselear Polytechnic Institute. Entirely new and complete laboratories will be constructed for quantitative analysis, for organic chemistry and for physical chemistry. Material enlargement will be provided for the food analysis and gas analysis laboratories, and new space assigned for lecture room and recitation room needs. The great increase in number of students entering for the course in chemical engineering has demanded these extensions. Work on the new construction will be started in March, 1918, at which time also ground will be broken for four new dormitories.

Dr. F. L. Pickett, formerly associate professor of taxonomy and ecology at the State College of Washington, has been made head of the department of botany at that institution to fill the vacancy in the department of botany made by the resignation of Dr. I. D. Cardiff.

Professor Walter Burton Ford has been promoted to a professorship of mathematics in the University of Michigan, and James Garret Van Zwaluwenburg to a professorship of roentgenology.

Mr. Geo. E. Crofoot has been promoted from instructor in mechanical engineering to assistant professor of mechanical engineering in the Towne Scientific School of the University of Pennsylvania.

Mr. E. G. Gaul, M.Sc., lecturer in bacteriological chemistry at the University of Manchester, has been appointed part-time demonstrator in chemistry in the university department. Mr. G. Hickling, D.Sc., has been appointed reader in paleontology and in the absence of Professor Holland, acting director of the geological laboratories.

DISCUSSION AND CORRESPONDENCE

THE MANUFACTURE OF OPTICAL GLASS IN AMERICA

To the Editor of Science: There is an obvious lesson of general interest and of importance in national welfare in the present situation concerning the manufacture of optical glass in this country. That lesson relates in principle to the injury to important manufacturing interests resulting from a large consumer becoming the sole producer of a material vital to that line of manufacture. When expert scientific knowledge is involved it is well that scientific men be alive to the consequences of certain lines of activity.

Four years ago this country imported annually about half a million dollars worth of optical glass, chiefly from Schott in Jena, Mantois in Paris and to some extent from Chance in England. At the outbreak of the war the German supply ceased, while the French and English supplies were limited to that not required for war purposes. Six of the large consumers of optical glass, a government bureau and three glass manufacturers at once started experimental work in this country on the manufacture of optical glass. The entire normal demand for this material is barely sufficient to pay overhead and a modest profit to a single manufacturing concern. But two of these would-be producers have faced the very considerable development expense and brought their production to a factory basis. One of them is a large consumer of optical glass, the other a large manufacturer of plate glass.

The situation faced by the independent consumer is a difficult one. He naturally can not depend upon his largest competitor for his raw material. Neither can the plate-glass manufacturer be depended upon as a permanent source of supply since his large orders for his regular product are much more remunerative. The outlook is therefore rather dismal both for the independent consumer and for the future manufacture of optical glass in America.

Optical glass manufacture, like so many other industries newly taken over in this country, is extremely sensitive to the favor of the capitalist as well as of the scientific expert and skilled laborer. Optical glass has been successfully made in this country in small experimental batches at various times for at least thirty years back, but no one would risk the necessary capital in a business with a demand so circumscribed and a margin of profit so limited. At present a concern devoted exclusively to optical glass, booking the entire American demand might weather the return to normal trade conditions. With the business split into at least two parts, one chief producer a large consumer, another operating it as a trivial side issue, the industry is unlikely to survive.

P. G. Nutting

Pittsburgh,
October, 1917

A NOTE ON THE "AGE AND AREA" HYPOTHESIS

Professor DeVries'[1] recent endorsement of the hypothesis advanced by Willis that the range of any plant, barring barriers, depends upon the age of the species, is a most curious illustration of how uncritical a man becomes who is obsessed with a theory. The Willis hypothesis has already been satisfactorily dealt with by Sinnott[2] in the pages of Science and I wish only to add one or two brief comments.

Neither Willis nor DeVries appear to have any knowledge of or interest in the facts of paleontology, certainly the latter, since he is an evolutionist of a sort, might have selected a name for his supposed factor that had not already been used in a perfectly definite way for a process diametrically the opposite of saltation. This has all been well said by former critics and I mention it in the present connection merely as more cloth off the same piece as the adoption of the Willis hypothesis.

Regarding barriers, we are familiar with certain gross kinds such as mountain ranges and seas, but who can successfully formulate the interrelations of organisms with one another and with their environment and the less obvious but no less real barriers that result from these correlations? One is reminded of Darwin's classic explanation of the relationship between cats and red clover, in which case spinsters might prove an effective barrier to field mice and offer optimum conditions for the spread of clover.

With reference to New Zealand, a philosophic botanist would have to account for very many plant radiations of different ages and from different directions—certainly the present flora of New Zealand can not legitimately be postulated as having entered that region as a unit at the central point advocated by Willis, nor can the flora of any region as a whole be dated from one period of time or from a single geographical point.

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[1] Science, N. S., Vol. 45, pp. 641–642.

[2] Science, N. S., Vol. 46, pp. 457–459.

Finally the statement that the dying out of species is a rare event is overwhelmingly opposed by all of the facts of paleontology and by all of the facts of history unless its adherents are prepared to accept the Mosaic cosmogony. This comment is as true of vertebrate and invertebrate paleontology as it is of plants. In the case of the last the probability is very great that the present flora of the globe represents a minute fraction of the extinct floras. Pointing in the same direction is the well-authenticated fact that in all the orders of plants that are prevailingly arborescent the geologic distribution where it is known is found to have been more extensive than the present distribution. The same statement is true of the higher animals and of such invertebrate groups as I am familiar with.

So-called monotypic genera, whether plant or animal, at least in the majority of cases, are relicts of a once wider distribution. Among plants this is strikingly true of arborescent forms and needs qualification only in the case of certain mainly herbaceous, relatively modern and prevailingly temperate groups such as the Papilionaceæ, Labiatæ, Scrophulariaceæ, Plantaginaceæ, Valerianaceæ, etc.

EDWARD W. BERRY

THE JOHNS HOPKINS UNIVERSITY

SCIENTIFIC BOOKS

A Text-book of Sanitary and Applied Chemistry; or, the Chemistry of Water, Air and Food. By E. H. S. BAILEY, Ph.D., Professor of Chemistry, University of Kansas. Fourth Edition revised. New York, The Macmillan Company. 1917. Cloth. 12mo, xxiv + 394 pp. Price $1.60.

As Dr. Bailey says in his preface, the object of the book is to furnish a text, for the use of students, upon chemistry as applied to the most important topics having to do with daily life in the household. The opening chapters deal with the Atmosphere, Fuels, Heating and Ventilation, Lighting, Water, Sewage, Textiles, Soap, Disinfectants and Poisons. The second half of the book treats of the chemistry of food. The treatment is naturally descriptive only and does not cover analytical processes. Throughout the text there are distributed 197 well selected experiments which will greatly help to fix important facts in the student's mind.

W. P. MASON

SPECIAL ARTICLES

THE UFFINGTON SHALE OF WEST VIRGINIA AND ITS SUPPOSED MARINE FAUNA[1]

AT a number of localities in northern West Virginia the Uffington shale of I. C. White[1a] lies at the base of the Conemaugh formation, occupying the interval between the Mahoning sandstone above and the Upper Freeport coal of the Allegheny formation below. It is a dark shale, a portion or the whole of which is sandy and bears plant fossils in abundance. It is variable in thickness, forty feet being about the maximum reported, while over much of the area it is lacking altogether, the sandstone being in contact with the coal. The replacement of the shale by the sandstone is clearly the result of erosion as is indicated by the sinuous contact between the two strata, the shale often varying in thickness as much as twenty feet in a distance of a hundred yards.

In 1871, John J. Stevenson, in a paper entitled: "A geological examination of Monongalia county, West Virginia," by John J. Stevenson; together with lists of fossils and descriptions of new species, by F. B. Meek,"[2] described a "dark colored, fine grained, argillaceous" shale overlying the "Upper Freeport" coal and containing abundant invertebrate fossils. Its thickness is given as 12 feet. It is said to be best exposed in the "bluff bordering the bottoms two or three hundred yards above the old 'Point House.'" It is also reported as underlying the "Mahoning" sandstone. Meek's list of fossils includes 7 brachiopoda, 13 pelecypoda, 10 gastropoda, 2 cephalopoda, a trilobite and a crinoid, besides crinoid columns. Three new species of pelecypoda were described; namely, *Nucula anodontoides*, *Yoldia carbonaria* and *Y. stevensoni*. Stevenson informed I. C. White that most of his fossils were collected at the town of Uffington.[3]

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[1] Published by permission of I. C. White, state geologist of West Virginia.

[1a] I. C. White, West Virginia Geol. Survey, Vol. II., 1903, p. 323.

[2] West Virginia University, Board of Regents, Third Ann. Rept., 1871, for 1870, pp. 41 to 73.

White in 1903 described the Uffington shale at Uffington and reported Stevenson's fossils as found in it, thus describing it as bearing both plant and animal remains.[4]

Stevenson in 1906 repeats White's statement that the Uffington shale—which name he now employs for the first time—bears a marine fauna.[5]

Hennen in 1913 mapped the outcrop of the Upper Freeport coal of the area and described the Uffington shale,[6] but did not observe animal fossils in it.[7]

After a close examination of the area the following facts bearing on the location of the marine fossils have come to light, correlation and identification of strata being based on the work of White and Hennen:

At Uffington the Uffington shale is 30 feet thick, plant-bearing throughout and very sandy in the lower half. Above it lie in ascending order the Mahoning sandstone, 39 feet thick, clay-shales 20 feet in thickness, the Brush Creek coal, 6 inches thick, and 3 feet of dark shale of the Brush Creek limestone horizon containing abundant marine fossils. Above the latter is the Buffalo sandstone, 16 feet thick.

At Rock Forge, 4 miles east of Uffington, stands the old "Point House," a frame dwelling, a relic of the settlement built during the operation of the Deckers Creek Iron Works which has been inactive since about 1855. Here the "bluff" referred to by Stevenson is capped by the Buffalo sandstone overlying 13 feet of dark shale containing abundant marine invertebrate fossils, the Brush Creek limestone horizon, which is just above the level of Deckers Creek. The strata at this point dip to the west, and seven tenths of a mile to the northeast the Upper Freeport coal rises to the creek level with the Mahoning sandstone resting directly upon it, no shales intervening between them.

It is thus seen that the dark fossiliferous shale of Stevenson at Rock Forge is Brush Creek. It was found to contain a number of the species listed by Meek.

Stevenson's description of his fossil bed does not agree with the characters of the Uffington shale at Uffington. It is less than one third as thick—the shales do not thin down in the immediate vicinity of the town—no sandy shale is reported and the strikingly abundant plant remains are not noted, nor does another fossiliferous stratum of black shale appear in the section below the well-marked Ames limestone, with which neither of the strata under discussion could have been confounded.[7a] It is therefore concluded that Stevenson collected marine fossils from the Brush Creek and not from the Uffington and it appears that at the time of writing he correlated the coal which lies below the true Uffington with the "Kittanning." This coal he mentions as seen at low water in the Monongahela River between Morgantown and Uffington and is the Upper Freeport of White and Hennen. It is therefore apparent that Stevenson's "Upper Freeport" is a higher coal. From these considerations it seems that there is little doubt that the Brush Creek coal and fossiliferous shale are Stevenson's "Upper Freeport coal" and "Dark shale just below the Mahoning sandstone," respectively. Diligent search by the writer failed to reveal marine fossils in the Uffington shale, while a number of Meek's listed species were found in the Brush Creek. Besides the writer, Messrs. S. B. Brown, David White, J. W. Beede and R. V. Hennen[8] have examined the Uffington shale at Uffington and vicinity without discovering marine fossils.

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[3] I. C. White, oral communication.

[4] W. Va. Geol. Surv., Vol. II., p. 323.

[5] "Carboniferous of the Appalachian Basin," Geol. Soc., America Bull., Vol. 17. 1906, p. 132.

[6] R. V. Hennen, West Virginia Geol. Surv., Report on Monongalia, Marion and Taylor counties, p. 321.

[7] Oral communication.

[7a] A sparse marine fauna is occasionally found in the green and yellow shales of the Pine Creek limestone horizon above the Buffalo sandstone.

Studies of the Conemaugh formation in West Virginia and Maryland by the writer have not revealed a marine fauna at this horizon nor has such been reported by other observers in these and adjoining states, with the exception of the instances mentioned above and two other West Virginia localities reported by Stevenson. These places are: in Wirt county 8 miles north of Burning Springs[9] and at Cutright in Upshur county.[10] These localities have since been studied by members of the West Virginia Geological Survey during the preparation of county reports. From the similarity of the sections given by the different observers[11] the fossiliferous members at these localities also appear to be Brush Creek.

In Ohio the shale is reported by Condit but marine fossils were not found.

The Uffington shale may then be re-defined as follows:

The Uffington shale is a plant-bearing bed of shale, frequently sandy in the lower portion, of non-marine origin, occupying in places the interval between the Upper Freeport coal and the Mahoning sandstone, and indicating by its variable thickness and undulating upper surface that erosion took place over the area of its outcrop before or during the deposition of the Mahoning sandstone. The maximum reported thickness of the shale is 40 feet and, though lacking in many places, its appearance at widely separated points in Maryland, West Virginia and Ohio shows that its former distribution was perhaps general in the Appalachian Carboniferous area.

W. Armstrong Price

West Virginia University,

BOSTON MEETING OF THE AMERICAN CHEMICAL SOCIETY

The fifty-fifth meeting of the American Chemical Society was held at the Massachusetts Institute of Technology, Cambridge, Mass., from September 10 to September 13, inclusive. The general program was carried out under the able leadership of Professor Julius Stieglitz, president of the society, and Dr. Charles L. Parsons, secretary, while the local arrangements were under the direction of Professor H. P. Talbot, assisted by the chairmen of the numerous committees. The various divisions were presided over by J. E. Breckenridge, T. J. Bryan, E. H S. Bailey, L. F. Kebler, L. E. Weber, C. L. Alsberg, J R. Bailey, H. P. Talbot, and H. E. Howe.

During the session, the usual order of business was carried out, consisting of meetings of the council, with general and public meetings. A strong feature of the meeting was the stress placed upon "War Service of the Chemist." A shore dinner at the Hotel Pemberton, held on Tuesday evening, was much enjoyed and served as a pleasant break in the work before the Society. Wednesday evening was given over to the address by President Stieglitz, who took for his subject, "The Outlook for Chemistry in the United States." This address was printed in the issue of Science for October 5.

During the entire week, the time was taken up by the reading of papers.

DIVISION OF BIOLOGICAL CHEMISTRY

C. L. Alsberg, *Chairman.*

I. K. Phelps, *Vice-Chairman and Secretary.*

Abstracts have been received of the following papers:

Oxidase action in the nucleus: W. J. V. Osterhout. The Indian pipe (*Monotropa uniflora*) contains a colorless chromogen which darkens on oxidation. This process takes place more rapidly in the nucleus than in the cytoplasm, indicating that the nucleus is the center of oxidation in the cell.

The dynamics of the process of death: W. J. V. Osterhout. Determinations of the electrical conductivity of living tissue enable us to follow the process of death in the same manner as we follow chemical reactions *in vitro*. The process usually proceeds as a monomolecular reaction which is somewhat accelerated or inhibited at the start. It is probable that we have to do with consecutive reactions, in which case the acceleration or inhibition is easily explained. The same assumption enables us to give a quantitative explanation of injury and of recovery.

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[8] Oral communication from S. B. Brown and R. V. Hennen.

[9] Geol. Soc America Bull., Vol. 17, 1906, p. 149. "Carboniferous of the Appalachian Basin," by J. J. Stevenson.

[10] Idem., p. 135.

[11] R. V. Hennen, W. Va. Geol. Surv., Wirt, Roane and Calhoun counties, Sept., 1911, p. 258; and I. C. White, W. Va. Geol. Surv., Vol. II., 1903, p. 279 (recent field work by D. B. Reger in the preparation of a report on Upshur county confirms the correlation of I. C. White).

The dynamics of photosynthesis: W. J. V. OSTERHOUT and A. R. C. HAAS. When plants of *Ulva* are taken from darkness and exposed to light the process of photosynthesis goes on at a regularly increasing speed until a steady rate is reached. This may be explained by assuming that a catalyst is produced in light. The values calculated upon this hypothesis are in good agreement with the observed values.

Note on the physiological action of Cordyceps sinensis: C. L. ALSBERG and J. F. BREWSTER. It is a practise among certain of the Chinese to extract the tufts caused by the growth of *Cordyceps sinensis* on caterpillars and use the extract for medicinal purposes. Extracts made both of the tufts separately and of the tufts with the caterpillars when injected into rabbits proved to be toxic.

The influence of phosphates on the action of alphacrotonic acid on plants: J. J. SKINNER and F. R. REID. Alpha crotonic acid in amounts of 25 and 50 p.p.m. was found to be very harmful to wheat plants grown in nutrient culture solutions. The solutions were composed of calcium acid phosphate, sodium nitrate and potassium sulphate and were prepared according to the triangular system. Growth was reduced about 50 per cent. when the material was used in amounts of 50 p p m. In cultures containing 80 p.p.m. P_2O_5 growth was reduced 30 per cent., in cultures containing 40 p.p.m. P_2O_5 growth was reduced 45 per cent., and in cultures with no P_2O_5 growth was reduced 55 per cent. When the material was used in the cultures in amounts of 25 p.p.m. growth was reduced about 30 per cent. In cultures having 80 p.p.m. P_2O_5, growth was reduced 9 per cent., and in those having 40 p.p.m. P_2O_5, 28 per cent., and where no P_2O_5 was present 34 per cent. Phosphate seemed to have an ameliorating effect on the harmlessness of the crotonic acid. NaH_2PO_4 used in the place of $CaH_4(PO_4)_2$ in the culture solutions had a similar effect on the action of the crotonic acid. Experiments using Na_2HPO_4 and also Na_3PO_4, showed that each of these phosphate salts, regardless of the character of the base, in combination had an action antagonistic to the harmfulness of alphacrotonic acid.

The oxidation of vanillin to vanillic acid by certain soil bacteria: WILLIAM J. ROBBINS and ELBERT C. LATHROP. A bacterium, apparently specific for vanillin, has been isolated from an Alabama soil. This organism when grown in a medium of inorganic salts with vanillin as the sole source of carbon, in the course of five days completely oxidized vanillin to compounds of a nonphenolic character. The first oxidation product has been isolated and its identity as vanillic acid has been established by the mixed melting points, the crystalline form and solubilities, the color reactions, the neutralization equivalent, methoxyl determination and organic combustion. By means of color reactions the rate of oxidation of vanillin to vanillic acid and the rate of the ensuing oxidation of vanillic acid has been determined. Vanillin has been found in a number of field soils and the infertility of some of these soils may be due to vanillin. Vanillic acid has also been shown to be harmful to growing plants. The biological oxidation of these harmful soil compounds and the effect of fertilizer compounds on this biological transformation is therefore of special interest in soil fertility.

The value of yeast "vitamine" as a supplement to a rice diet: A. D. EMMETT and L. H. MCKIM, Research Department of Parke, Davis & Co., Detroit. The criteria for estimating the value of the diet of polished rice supplemented with vitamine for polyneuritic pigeons was to determine the rate of full recovery of pigeons that had been brought out of the typical polyneuritis attack by a treatment of the Seidell yeast vitamine. This was indicated by the body weight curves before and after treatment. The control vitamine-containing diet for the treated birds was natural unpolished rice. Other feeds were also used—corn, barley and oats. It was found that this yeast vitamine preparation was a most excellent agent for bringing about recovery from the typical attack of polyneuritis; that, as a supplement to polished rice, when used in rational amounts (equal to slightly more than the dose needed for treatment) the diet was adequate for producing moderate gains in weight, but that these gains were much less than those obtained with the control or unpolished rice diet. Corn produced smaller gains than unpolished rice but more than polished rice. Barley produced fair gains for a time but later the pigeons lost weight. Oats proved to be very inferior. The results suggest that this vitamine preparation, when used in amounts commensurate with rational therapy, is a very valuable adjuvant to a vitamine-poor diet but in order to obtain the very best results one should have for the patient a dietary containing foods rich in vitamine.

The growth promoting value of the lactalbumins obtained after separating casein by (a) *hydrochloric acid and* (b) *lactic acid culture:* A. D. Emmett and M. E. Slater, Research Department of Parke, Davis & Co., Detroit. The lactalbumins used were obtained from skim milk whey. In one case, the casein was removed from the skim milk by a slight acidification with hydrochloric acid and in the other it was thrown out by using a lactic acid "starter" and allowing the milk to incubate until sufficient acid was formed to cause the separation. The two lactalbumins were compared as to their growth promoting value by feeding young rats that had been kept on a maintenance ration. It was found, on a low protein plane, that the lactic acid culture lactalbumin had very little growth producing value when compared with the hydrochloric acid lactalbumin. The influence of various factors involved was studied among them—varying the quantity of lactalbumin, adding cystine and increasing the total protein intake.

The influence of accessory substances on growth, with a low protein ration containing lactalbumin from lactic acid whey: A. D. Emmett and M. E. Slater, Research Laboratory of Parke, Davis & Co., Detroit. Young rats which had been on maintenance were put upon a basal ration low in protein but ample in energy and mineral content. The protein concentrate used was corn gluten. This was supplemented with lactic acid, lactalbumin. Butter fat was omitted. Vitamine preparations (water soluble) were added to the basal relation after a test period showed that the expected rate of growth did not take place. In fact, during this test period, there was almost no response to the change in the ration from maintenance to basal. Upon replacing part of the lard with butter fat, there was a slight increase in growth; adding vitamine preparation B to the basal ration, there was some effect produced; and on adding vitamine preparation A, a decided gain in weight resulted which compared favorably with the growth curve obtained on using the hydrochloric acid lactalbumin.

On the origin of the humin formed by the acid hydrolysis of proteins III. Hydrolysis in the presence of aldehydes II. Hydrolysis in the presence of formaldehyde: Ross Aiken Gortner and George E. Holm. Hydrolysis in the presence of formaldehyde completely alters the nitrogen distribution obtained by Van Slyke's method. Black insoluble humin is formed from tryptophane and no other known amino acid is concerned in the reaction. The primary reaction of black humin formation involves only the indole nucleus and not the α amino group of the aliphatic side chain of tryptophane. Formaldehyde forms a soluble humin with tyrosine which is precipitated by $Ca(OH)_2$. Hydrolysis in the presence of formaldehyde causes enormous increases in the ammonia fraction but the increase is not due to ammonia but to volatile alkaline compounds. The detailed paper will appear in the *Jour. Amer. Chem. Soc.*

On the relative imbibition of glutens from strong and weak flours: Ross Aiken Gortner and Everett H. Doherty. The gluten was washed from both "strong" and "weak" flours and the hydration capacity of the colloids measured by immersing weighed disks in different concentrations of certain acids, allowing them to remain a definite length of time and again weighing. Lactic and acetic acids produced greatest imbibition, the form of these hydration curves being very different from those of hydrochloric and oxalic acids which produced much less hydration. The gluten from a "weak" flour has a much lower *rate of hydration* and a much lower *maximum hydration capacity* than has the gluten from a "strong" flour. Gluten from a "weak" flour changes from a gel to a sol at a much lower degree of hydration than does that from a "strong" flour. There is an inherent difference in the colloidal properties of the glutens from "strong" and "weak" flours and these glutens would not be identical even if the flours had originally had the same salt and acid content. The paper will be published in *Jour. Agr. Res.*

The nitrogen distribution in protalbinic and lysalbinic acids: Ross Aiken Gortner and Cornelia Kennedy. Lysalbinic and protalbinic acids were prepared from egg albumen by Paal's method and their nitrogen distribution, together with that of the original egg albumen, determined by Van Slyke's method. No marked difference was observed in any of the fractions although both of the derived products show a somewhat greater apparent lysine content. This is probably due to ornithine derived from arginine. The analyses furnish no evidence as to whether or not these "acids" are true chemical compounds or as to whether or not their structure is more simple than is that of egg albumen. The paper will appear in the *Jour. Amer. Chem. Soc.*

The effect of prolonged acid hydrolysis on the nitrogen distribution of fibrin with especial reference to the ammonia fraction: Ross Aiken Gortner and George E. Holm. Fibrin was boiled with 20 per cent. HCl for varying periods of time ranging from 1 hour to 6 weeks, the ammonia fraction increases continuously showing a 150 per cent. increase at the end of six weeks over that obtained at the end of twelve hours. This increase in ammonia comes almost entirely from the deamination of mono amino acids. The ammonia fraction of a twenty-four or forty-eight-hour hydrolysate can not be taken as an absolute measure of amide nitrogen for some "deamination" nitrogen is undoubtedly present, the amount depending both upon the particular protein and the length of hydrolysis. The paper will appear in the *Jour. Amer. Chem. Soc.*

Comparative analyses of fibrin from different animals: Ross Aiken Gortner and Alexander J. Wuertz. Fibrin has been prepared from the blood of cattle, sheep and swine and the nitrogen distribution determined by Van Slyke's method. No differences significantly greater than the expected experimental errors were found. It would thus appear that fibrin from any of these three sources can be used interchangeably in experimental work without invalidating the results. Whether or not this is true for fibrins from other sources remains still an open question. The paper will appear in the *Jour. Amer. Chem. Soc.*

The nitrogen distribution of fibrin hydrolysed in the presence of ferric chloride: Clarence Austin Morrow. When a protein is hydrolyzed in the presence of ferric chloride an accurate nitrogen distribution can not be obtained. There is a substantial increase in the ammonia N, due probably to deamination of amino acids at the higher temperature of hydrolysis. The acid soluble humin increases at the expense of a corresponding loss from the "filtrate from the bases," thus indicating that the earlier conclusion regarding the soluble humin N of soils was incorrect and that this fraction of a soil hydrolysis may be of protein origin. Since hydrolysis in the presence of either carbohydrates or ferric chloride radically changes the nitrogen distribution of proteins, it is obvious that no accurate knowledge of *soil proteins* can be obtained by applying Van Slyke's method to soils.

A new form of ultra-filter; its uses in synthetic and biological chemistry: P. A. Kober. A new form of ultra-filter is described which depends on pervaporating both dialysis and diffusate solution during dialysis. Its usefulness in filtering off humus and other coloring matter in biological work and organic synthetic work, as well as colloids in general, is pointed out. The apparatus makes it possible now, for the first time, to dialyze quantitatively.

Studies on Piper bredemeyeri, an adulterant of matico: A. Viehoever and M. G. Mastin. A study has been made of the volatile oil obtained from *Piper bredemeyeri*, an adulterant of matico, *Piper angustifolium*. It was found that the volatile oil did not yield asaron, which is obtained from genuine matico, nor matico camphor, obtained from *Piper angustifolium* var. *ossanum*. The oil from *Piper bredemeyeri*, containing over 50 per cent. of dillapiol, was very similar in composition to that reported to be obtained from *Piper mandoni*. The chemical and botanical similarities suggest that the name *Piper mandoni* has been given to plants belonging to the species *Piper bredemeyeri*. A paper on the subject is in preparation.

Studies on mustards and mustard substitutes: A. Viehoever, C. O. Ewing and J. F. Clevenger. Work on monographs of mustards and mustard substitutes has progressed considerably. New supplies from India, China and Japan have been identified on the basis of studies including the botany and chemistry of the seeds, and also studies of plants grown from the seeds. Material of Indian brown mustard proved to be substituted by Indian rape or tori, *Brassica napus* var. *dichotoma*. Chinese mustard, *Brassica juncea*, was found to be usually improperly collected, containing a considerable amount of immature seeds and weed seeds, including generally *Eruca*. A preliminary study of the volatile oils obtained from Chinese mustard, *Brassica juncea*, and Japanese mustard, *Brassica cernua*, indicates that they are mixtures containing only in part allylisothiocyanate. The volatile oil from *Brassica campestris sativa chinensis*, another adulterant of mustard, proved to be crotonylisothiocyanate. This oil has no mustard qualities. Since the plant grows very vigorously, plans are under way to utilize it either for greens and salads or for stock feed. The seeds yield over 40 per cent. of a fatty oil with the general characteristics of rape oil.

An alkaloid from lupinus leucopsis: O. F. Black. The European lupines have been very extensively studied especially in respect to their alkaloids. No work has been reported on the native species of the plant which grow abundantly on western ranges. *Lupinus leucopsis*, suspected of causing the poisoning of cattle, was tested for alkaloids and gave positive reactions. The alkaloid was thereupon isolated in the following manner: the seeds were finely ground and extracted by macerating at room temperature with 80 per cent., alcohol slightly acidified with HCl. The alcohol was driven off by boiling in vacuo and the residual solution quantitatively precipitated with Mayer's reagent. The precipitate washed and decomposed with H_2S, filtered, and the filtrate extracted with chloroform which removed the alkaloid as the hydriodede. On evaporating the solvent the salt remained as lemon yellow needle crystals, mpt. 246°. It could be recrystallized from water or alcohol. The alkaloid, prepared by treating the salt with silver oxide, was colorless and amorphous and resisted attempts to crystallize it. A preliminary analysis indicated that the formula was probably $C_{15}H_{26}N_2O_2HI$, which does not correspond with the formula of any alkaloid hitherto isolated from lupines. Also the common European varieties when subjected to the same treatment failed to yield any body of a similar nature. It, therefore, seems reasonable to conclude that it is a new alkaloid. It is intended to continue work on it when more material can be procured.

On the histology and chemistry of secretory and nectary glands of the cotton plant: A. Viehoever and E. E. Stanford. The occurrence, distribution, and histology of secretory as well as nectary glands has been established. Microphotographs have been prepared which show clearly the structure and lysigenetic character of the secretory glands. The chemistry of these glands is under investigation, and while not yet completed, very interesting results have been obtained. The glands located in parts not exposed to light, especially in seeds and roots, contain gossypol, while those of insolated parts, namely, stems, leaves, bolls and flowers, contain querimeritrin and anthocyans. Other genera belonging together with *Gossypium* to Hibisceae have been studied in regard to the presence of secretory glands. While some of the genera did not show them, others, especially *Thurberia* (wild cotton) showed these glands very conspicuously and very similarly arranged as in the case of cotton plants.

Studies on edible and poisonous beans of the Lima type (Phaseolus lunatus): A. Viehoever, C. O. Ewing and M. G. Mastin. Work on cyanogenesis consisted of the investigation of poisonous and edible beans of the Lima type, *Phaseolus lunatus*. Examination of a considerable number of domestic Lima beans disclosed the fact that they all yield hydrocyanic acid under certain conditions, the amount of which, however, does not exceed 10 mg. per 100 gm. of beans. Foreign beans of the same type, imported from the Orient or South America, were found to contain in certain instances a considerably higher amount. As a result of these findings a large number of shipments of such beans, especially Rangoon or Burma beans, were excluded from import. The glucoside, yielding hydrocyanic acid, has been isolated and its characteristics determined. This facilitated the working out of a satisfactory reliable method for obtaining the maximum available amount of hydrocyanic acid from the beans. It also assisted in experiments concerning the removal of the glucoside from the bean.

Oxalic acid in foods and spices: A. Viehoever, W. F. Kunke, and M. G. Mastin. A large number of common foods and spices have been examined for the presence of oxalic acid and its salts. In some instances this has been supplemented by quantitative determinations, namely: Rhubarb stalks, contained 0.39 per cent. of oxalic acid and rhubarb leaves contained 0.84 per cent., in the form of soluble oxalates and insoluble calcium oxalate. These amounts were found in fresh material obtained on the market. In the dried root of rhubarb, used as a drug, the amount of oxalic acid was 10.77 per cent., being present in the form of calcium oxalate. No soluble oxalates were found. The amount found in spinach was 0.82 per cent., and that in sweet potatoes 0.10 per cent. In beets, 0.17 per cent., and in dried figs 0.21 per cent. Dasheen contained 0.49 per cent., and the common bean (*Phaseolus vulgaris*) 0.4 per cent. Acheen pepper, containing usually a varying amount of more or less undeveloped fruit, showed 1.61 per cent. oxalic acid in the solid, almost developed fruits, and 3.39 per cent. in the fruits which were more or less empty. The amount of oxalic acid found in ground pepper can possibly be used to detect the presence of added pepper shells.

(*To be continued*)

SCIENCE

FRIDAY, DECEMBER 7, 1917

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THE CHEMICAL BASIS OF AXIAL POLARITY IN REGENERATION

I

WHEN a piece of a stem is cut out from a plant one or more new shoots will usually arise at the apical, and roots at the basal end of the piece. This phenomenon of axial polarity was explained by the older botanists as being due to a flow of shoot-forming substances to the apex and of root-forming substances to the base. The gathering of these substances at opposite ends of the piece was believed to be responsible for the phenomenon of polarity in regeneration. While this may or may not be correct, the writer has recently found facts which suggest an additional or a different mechanism for this polarity, namely, that the apical bud suppresses the growth of the buds situated more basally in the stem by sending out inhibitory substances in a basal direction.

The experiments were made on *Bryophyllum calycinum.* Each node of the stem of this plant has two leaves in an opposite position, and in the axil of each leaf is found a dormant bud capable of giving rise to a shoot. The line connecting two buds of one node is at right angles to the line connecting the two buds of the next node.

Experiment I.—A piece of stem, containing six or more nodes, is cut out from a plant, all the leaves are removed and the piece is put into a horizontal position with the line connecting the two buds of the most apical node vertical. In this case both buds in the apical node may begin to grow, but as a rule only the upper bud will continue to grow, while the growth of the lower bud will soon stop altogether or will be considerably retarded. None of the buds in the other nodes will grow out. Roots will grow chiefly on the under side of the stem, but in the last node and at the cut end they may form on the upper side as well as on the lower side of the stem.

Experiment II. is the same as Experiment I., except that the upper apical bud is cut out. In this case the lower apical bud will grow rapidly, but in addition one or both of the buds of the node next to the apical will grow out. These buds never grow out when the upper apical bud is preserved and healthy.

Experiment III. is the same as the previous experiment except that the lower apical bud is removed, while the upper one is preserved. In this case, the upper apical bud will grow out, but none of the others.

It follows from these experiments that the upper apical bud inhibits or retards the growth of the lower apical bud as well as that of the rest of the buds; while the lower apical bud can not suppress the growth of the buds in the node behind. The writer has repeated these experiments in many modifications, among which those on longitudinally split stems are the most striking. The results were uniform.

All these observations are intelligible if we assume that a bud when it begins to grow produces and sends out inhibitory substances toward the base of the stem. These substances flow in the conducting vessels in the same half of the stem where the bud lies; when one apical bud is above and one below, the two buds in the next node are in a lateral position between the upper and lower half of the stem. Hence the inhibitory substances sent out by the upper apical bud can reach the two buds in the next node behind and inhibit their growth, since these buds lie directly below or on the lower level of the conducting vessels from the upper apical bud; while inhibitory substances sent out by the lower apical bud can not reach the buds in the node behind in large quantity, since these buds are on the upper level or slightly above these conducting vessels. When the two lateral buds grow out they will inhibit the growth of all the buds behind, each bud covering a territory of one half stem.

The alternative hypothesis assumes that since the apical bud is the first to grow out it will absorb all the shoot-forming material.[1] If we assume that the shoot-forming material has a tendency to rise this hypothesis may explain the facts also. But the following experiment, which seems crucial, decides in favor of the other assumption.

A piece of stem containing a number of nodes is suspended horizontally, as in the previous experiments, with the two apical buds in a vertical line. All the leaves are removed with the exception of those at the apical node. Here the petioles of the leaves are left attached to the stem, the leaves having been cut off. The petioles will wilt in a week or ten days, but until then will prevent or retard the growth of the apical buds in their axils. The buds in the next node will begin to grow out and as soon as the petioles have fallen off the apical buds will also begin to grow.

The next step is decisive for testing the two hypotheses. If the inhibiting effect of the apical buds on the more basal buds is due to the fact that the buds which grow out first attract all the material from the basal part of the stem, the buds in the node behind the apical one, which grew out first, should continue to outstrip in growth the apical buds which began to grow out later. But if the inhibiting effect is due to an inhibitory substance being sent in the direction toward the base by the growing bud, the most apical bud should soon outstrip in growth those situated in the next node behind, although the latter had an earlier start. For according to this theory, the most apical buds should be sending substances toward the base which inhibit the growth in the next bud; while the most apical buds receive no such inhibitory substances. The results of the experiment are quite clear. As soon as the petioles at the apex fall off the axillary buds at the apex begin to grow out and soon not only outstrip in size those of the next buds behind but actually retard or stop the growth of the latter. This phenomenon seems intelligible only on the assumption that a growing bud sends out substances toward the base of the stem which directly inhibit the growth of the other buds.

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[1] This form of inhibition exists apparently in the leaf where the shoots which grow out first prevent other notches in the leaf from giving rise to shoots by absorbing the material needed for shoot formation. SCIENCE, 1917, XLV., 436; XLVI., 115; *Bot. Gaz.*, in print.

II

If the inhibition of shoot formation is due to special inhibitory substances it should be possible to show that the inhibition varies quantitatively with the mass of inhibitory substances produced in the growing bud, or with the mass of the latter. While the bud is too small for convenient quantitative experimentation, it can be carried out satisfactorily with the leaf. In a former paper the writer had shown that the leaf of *Bryophyllum* sends out material toward the base of the stem which favors root formation; and it also seemed possible that the leaf might send out substances in a basal direction which inhibit shoot formation. The sap from the leaf flows in conducting vessels situated in the same half of the stem where the leaf is attached.

When we suspend a stem of *Bryophyllum* with six or more nodes horizontally, and remove all the leaves except the two in the apical node, the stem will form no shoots as long as the leaves are alive, but an abundance of roots is produced in the stem. The two leaves, therefore, inhibit all the shoot formation in the buds situated basally from the leaf. When we remove one of the two apical leaves the axillary bud of this leaf will grow out and it will have the same inhibiting effect as the leaf in the previous experiment. We now make the following experiment.

Twelve long stems from which all leaves except one of the two apical ones have been removed are suspended horizontally, and the free axillary bud opposite the leaf is also cut out. Six stems are suspended with the leaf above, six with the leaf below. There is a striking difference in the two sets. When the leaf is below, shoots will develop either in the two lateral buds of the first node behind the leaf, or on the upper side of the second node behind the leaf. When the leaf is above, no shoots will develop in the next node behind the leaf but one shoot may grow in the second node behind the leaf, *on the lower side alone.* These shoots will develop more slowly than those in the stems whose leaf is on the lower side.

This is exactly the result which we should expect if the leaf sends out substances inhibiting shoot formation toward the base of the stem. These substances, being identical with or accompanying the root-forming substances, flow on that side of the stem where the leaf is, but have naturally a tendency to flow downward and not to flow upward. Hence, when the leaf is below it is possible for shoots to form in some (about 50 per cent.) of the stems in the first node behind the leaf, in which case the buds are on the upper level of the flowing sap; while when the leaf is above it is impossible for the buds in the first node behind the leaf to grow because they are on the lower level of the sap flow from the leaf. The bud on the lower side of the second node behind the leaf (when the latter is on the upper side of the stem) is outside the sap flow and hence it may develop.

When we work with a large apical leaf attached to a short stem (the free apical bud opposite the leaf is always removed in these experiments) containing only two nodes behind the leaf, everything is as described for long stems. When, however, the piece of stem behind the leaf is smaller, containing only one node, no shoot can grow on this stem even when the leaf is below. The mass of inhibitory substance sent out by a large leaf will flood the buds in this node with inhibiting material. Occasionally a bud starts to grow but stops before a leaflet has time to unfold. Such a stem will form an abundance of roots at the base. If, however, we reduce the size of the apical leaf by cutting away nine tenths of its mass, most or practically all the stems will form shoots in the node behind the leaf; but roots in such stems either do not develop at all or only with long delay.

The leaf, therefore, sends substances to the basal part of the stem which inhibit shoot formation and favor root formation, and the mass of these inhibitory substances decreases with the mass of the leaf, and apparently parallel with the mass of root-forming substances sent to the base of the stem.

Another experiment is equally instructive. We have seen that when long stems having all but one apical leaf removed (and the opposite free apical bud also removed) are suspended horizontally, with the leaf above, no shoot will form on the upper side of the stem. When we reduce the size of the leaf sufficiently this inhibition ceases.

Again the objection might be raised that the inhibiting effect of the leaf on shoot formation in the region behind the leaf is due not to an inhibitory substance being sent out by the leaf but by nutritive substances needed for the growth of shoots being sent into the leaf by the stem. This is highly improbable not only on the basis of our knowledge of these processes but also on account of the following fact. When we cut off a leaf without its petiole, leaving the latter in connection with the stem, the petiole will dry out and fall off in a week or less. If, however, the petiole is detached from the stem but left attached to a leaf, it will not wilt, but remain fresh and green as long as the leaf is alive, which may be many months. This shows that nutritive material is furnished by the leaf to the stem, and not vice versa.

III

While these experiments show that the inhibiting influence of an apical bud on the growth of the more basal buds is due to one or more inhibitory substances being sent toward the basal end of the stem, the other main fact of polarity remains unexplained; namely, how it happens that the most apical bud grows out first. The writer is inclined to offer the following suggestion: In the normal plant, the substances inhibiting shoot formation are constantly flowing from the growing region toward the root of the plant. When we cut out a piece of stem and remove the leaves these substances will at first exist in every node, but will continue to flow toward the base. Hence the most apical node will be the first one to be free from these inhibitory substances and the bud or buds situated here can now begin to grow out. As soon as they grow out they will maintain a constant flow of inhibitory substances toward the base which will suppress the growth of buds in the more basal part of the stem.

The experiments, therefore, seem to prove that axial polarity in the regeneration of a stem is due to the fact that the apical bud (as well as an apical leaf) send out substances toward the base of a stem which inhibit the buds from growing out. These inhibitory substances may be identical with or may accompany the root-forming hormones. The most apical bud in an excised piece of stem will grow out first since it will be the first to be free from these inhibitory substances.

In a former paper the writer had pointed out that a leaf sends out substances, in an apical direction through the stem, which favor shoot formation.

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SOME COMMENTS ON THE THEORIES OF THE STRUCTURE OF MATTER[1]

Professor Lewis in his paper raised the question of valence. From the point of view of chemistry, valence has a definite meaning which can not be overlooked and which may be emphasized here. The conception of valence developed from a study of the regularities observed in the composition of substances, and is fundamentally purely descriptive. It is a classification which shows regularities in the capacity of certain atoms for combination, or for holding a definite number of atoms or their equivalents in combination. The continued study of chemical composition has, as a matter of course, extended the classification. The phenomena of oxidation, the ionization of substances in solution and otherwise, and similar properties, have brought forward the view that, choosing a suitable element or state of an element as the zero or neutral point, the valence of an element in a given combination may be denoted either by a positive number or a negative number. This view was adopted for individual cases some time ago by different chemists, but became of general interest when J. J. Thomson, using corpuscles, showed how this could be pictured readily, and applied in a simple manner.

A few words may be devoted to the fact that the classifications given by valence should involve no considerations of measures of relative stabilities of substances, although the existence of compounds depends upon stabilities and rates of decomposition. Stability discussions should not enter directly into questions of valence, but unfortunately this fact is often overlooked and much confusion has resulted.

The question of so-called polar and non-polar valence is one raised by Professor Lewis. At the present time the view that only non-polar bonds exist is probably held by no chemist. The electron conception of valence, based upon a study and comparison of organic and inorganic compounds, postulates polar valence only; in other words, each valence linking is equivalent to one atom functioning with a negative charge, and the other atom with a positive charge. The electrostatic view does not involve at first sight such questions as distribution of electrons within the atom, etc.

At the present time there are a number of chemists who advocate both polar and non-polar valences, even assuming both to be present in a molecule at the same time. The reasons for assuming the existence of non-polar valences appear to be negative ones. If direct evidence is lacking, or if ignorance is manifested with regard to the reactions of certain groups, or if these groups do not take part in the desired reaction with sufficient velocity, the existence of polar valences is denied. A strong argument in favor of assuming polar valences in organic compounds is, that if they are not assumed, two different types of oxidation reactions become necessary, and these two types would be contradictory. This was pointed out several years ago.[2]

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[1] This discussion was presented by Dr. Falk at the "Symposium on the Structure of Matter," held at the meeting of the American Association for the Advancement of Science in New York City, December, 1916.

Direct evidence for the polar nature of valences involved in the Grignard reactions is given by some recent experiments.[3] Without going into details, these results may be quoted.

RESISTANCE IN OHMS. (ORDINARY CONDUCTIVITY APPARATUS)

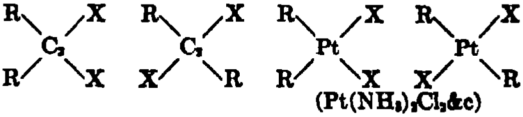
Ether	above 1 × 10^7
Ether containing ethyl bromide..	above 1 × 10^7
Ether containing 1.2 gm. magnesium as Grignard reagent (MgC_2H_5Br) per 100 c.c.	7. 1 × 10^8
Same with 0.3 mg. magnesium..	1. 0 × 10^8
1/50 *M* KCl aqueous solution....	1.26 × 10^8

A cell constructed with magnesium and platinum electrodes, and a dry ethereal solution of ethyl bromide containing a small amount of previously prepared Grignard reagent as solution gave electromotive forces of from 0.5 to 1.5 volts.

These results are of the greatest significance with regard to the question of polar and non-polar valence and indicate that the valence or linkings of organic compounds are of the same character as those of inorganic compounds. They bear out the explanation of the Grignard reaction on the basis of the electron conception of valence published several years ago, and in addition will unquestionably throw light on the processes operating in solutions, aqueous and otherwise.

With regard to Professor Jones's work on electromerism, some interesting developments may be presented. As we understand the term, electromerism means electronic tautomerism and includes substances structurally identical, but mutually transformable by an exchange of negative electrons between atoms composing the molecules. Thus ammonium nitrate, NH_4NO_3, and hydroxylamine nitrite, $NH_3OH\ NO_2$, while mutually transformable by a suitable exchange of negative electrons, since as far as the charges on the atoms are concerned they differ only in the valence of the nitrate and nitrite nitrogen atoms, are not structurally identical and would not, therefore, be classed as electromers.

Professor Jones in his paper considered electromeric nitrogen compounds. In electromers, the states of oxidation of certain atoms in the structural isomers are different. A number of years ago we showed that the explanation of the isomerism of a number of structurally identical organic compounds may be referred to the state of oxidation or the valence of certain atoms. The compounds referred to are generally known as geometrical or cis-trans isomers. Direct evidence based upon the ionization constants of organic acids[4] showed that the isomerism of maleic and fumaric acids is due to phenomena now included under electromerism while addition reactions of unsaturated carbon compounds lead to similar conclusions.[5] The evidence in detail is given in the published papers and need not be repeated here. It is possible to go somewhat farther. Werner and Pfeiffer[6] have placed in parallel the so-called geometrical isomerism of double bonded carbon atoms and the isomerism due to plane configuration of certain cobalt, chromium and platinum compounds:



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[2] Falk and Nelson, *Jour. Amer. Chem. Soc.*, 36, 209 (1914).

[3] Nelson and Evans, *ibid.*, 39 (1917) (January).

[4] Falk, *Jour. Amer. Chem. Soc.*, 33, 1140 (1911).

[5] Nelson and Falk, *School of Mines Quarterly*, 30, 179 (1909); Falk and Nelson, *Jour. Amer. Chem. Soc.*, 32, 1637 (1910).

[6] Werner, "Neuere Anschauungen auf dem Gebiete der anorganischen Chemie" (1913), pp. 343, 345; Pfeiffer, *Ztschr. physik. Chem.*, 48, 40 (1904).

Whatever explanation is accepted for the double bond isomerism, the same explanation will apply to the isomerism of the platinum compounds. Werner considers that the explanation of the spatial configuration applies to both. On the other hand, if the double bond isomerism is due to the directions of the valences which is the same as the distribution of the negative electrons in the acids, then the explanation of the isomerism of the platinum compounds should be based upon the distribution of the electrons in the platinum atom. There is, however, only one atom involved here, so that it appears as if this isomerism would furnish a method for showing the distribution or arrangement of the electrons in an atom, or perhaps the spatial configuration of the atom, different arrangements of electrons giving rise to possibilities of the existence of isomeric compounds. It is even possible, and perhaps very probable, that the different arrangements of the electrons might control the spatial positions of the combined groups. The spatial configurations deduced by Werner and others, then would exist, but would actually be an effect of the arrangement of the electrons. The positions of the combined atoms therefore would be a result of the isomerism and not its cause.

These platinum and similar metal compounds would then belong to the class of electromeric substances. Since this explanation means that the spatial arrangement of atoms or groups around a central atom depends primarily upon the spatial arrangement of the valence and also other electrons of that central atom, a further logical deduction would include all optically active isomers in organic and inorganic chemistry in the group of electromers. The spatial arrangements of the atoms or groups here would also be governed or controlled primarily by the arrangement of the electrons of the atom showing the optical activity.

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POSSIBILITY OF USING GRAVITY ANOMALIES IN THE SEARCH FOR SALT-DOME OIL AND GAS POOLS

The immense masses of common salt that have forced their way up toward the surface of the earth in Louisiana, Texas and other low plains regions where there is no hard rock within several thousand feet of the surface, seem to afford all the fascination and baffling questions that can be desired by the structural geologist, though thrilling encounters with such questions are usually sought in mountainous regions. Recorded and available notes on experiences in the sinking of the thousands of wells that have been put down on salt domes in the search for oil is dishearteningly scant, and yet sufficient to give a fair idea of the common extents, positions and shapes of the upper portions of the salt cores. If as much were known concerning their lower portions it might not only be possible to determine their cause and mode of growth with a fair degree of certainty, but to devise means of discovering by gravity observations, hidden domes, for some are scarcely evident from the surface, and perhaps many unsuspected ones with valuable oil and gas pools are scattered through the coastal portions of Louisiana, Texas and other regions.

Are the salt domes due to some process related to volcanic action? The domed form of the strata, which is much more commonly seen than the core itself, is such as might have been produced by a rising plug of igneous rock and even the masses of salt and associated secondary deposits might apparently have been produced indirectly by intrusions. On the other hand, though many very deep wells have been drilled in salt domes, igneous rock has rarely if ever been touched. Since there are numerous varieties of salt domes—some making a conspicuous hill, some through recent solution of the salt making a depression, and some having little or no effect on the surface, the salt core of some lying at slight depth and of others at great depth—it would appear that if they are due to intrusion, the igneous rock should have been found in some of them.

Furthermore, in areas of igneous activity intrusions have various forms, dikes being common, but salt domes are sharply localized, more or less equi-dimensional laterally, in length and breadth rarely measuring over two or three miles or less than one half mile. Although in an area underlain by a great thickness of unconsolidated strata intrusions may differ somewhat from those of other areas, still, since the country rock, being unconsolidated, is more likely a body of water than if it had been cemented into stone, it seems quite unreasonable to assume that either intrusions or secondary deposits made by circulating waters or gases emanating from them would be similar in form and size and short in lateral dimensions. The fact that salt domes are found on the northwest and southwest coasts of the Gulf of Mexico, and that, due perchance to more consolidated rock, igneous intrusions are common in territory between, invites investigation to determine whether or not gradation phases may be found between salt domes and intrusions. Such phases, however, seem to be poorly developed and the series, if there is one, incomplete. Also, although intrusions have made dome structures and hills on the surface in many parts of the world, no evidence of an overlying salt core seems to have been found.

Are the domes due, as has also been suggested, to forces of crystallization acting in some such way as they do in the growth of concretions, the salt being taken from saturated solutions and collected around some nucleus by molecular attraction? Ordinarily salt does not seem to behave in this way and the associated great deposits of dolomite, gypsum and other secondary substances would seem too much to ascribe to a kind of mass action not controlled by some other set of forces operating at or underneath the locus of salt-dome growth. The apparent lack of concentric structure and of small salt concretions, and the presence of certain minerals, such as sulphur and copper ores, seems to point to a deep-seated cause for the domes.

May the salt domes be due to a buckling and flowage of one or more beds of rock salt lying at great depth, as has been suspected concerning European salt domes or more indirectly to some process of isotatic adjustment? If so some of the salt cores should be connected below with the parent stratum or strata of rock salt, and the average mass of salt perhaps much greater than if it had developed in some other way. However, since the country rock is largely unconsolidated, and, on the whole, homogeneous, and the surface is smooth and horizontal, it would seem rather improbable that the bodies of salt could have been produced through differential pressure, though it must be admitted that a small stress difference operating for a very long time may accomplish a great deal, and once started the process might be somewhat self-accelerating. Also the association of salt, dolomite, gypsum, sulphur, copper, etc., suggests a Permian source. As a matter of fact, however, the few determinations of specific gravity of the country rock that have been made indicate that it weighs in its natural wet state no more than salt, if indeed as much, and it seems very improbable that there has been any considerable horizontal thrust pressure.

In any case from what has been learned by deep boring and from the various conceivable possibilities as to salt dome origin, it seems probable that the known upper portions of salt cores are underlain with (*a*) more salt, (*b*) clay and sand, or (*c*) igneous rock. Although it is possible that the clay and sand strata through which the salt rises, differ more or less markedly from it in specific gravity, the surprisingly little information available on the subject indicates that in their natural state the salt is appreciably the heavier. The writer has tested seven samples of common sandy clay and clayey sand from the Gulf Coast region, and the results indicate that although the specific gravity varies considerably, it is not far from that of salt. There is a real possibility, however, that the difference is great enough so that large bodies of rock salt not far from the surface can be detected by determinations of the intensity of gravity.

While investigating the "mud lumps" at the mouths of the Mississippi a few years ago the writer had occasion to study isostacy a little, for it seemed probable that the "mud lumps" were due to gravity—induced internal flowage of the delta. The question arose, may not the salt domes be due to some such solid or semisolid flowage? and another question immediately arose, namely, may not the domes have a perceptible effect on gravity? The domes of southern Texas and Louisiana are in a region that is very flat, and although some domes are marked by knolls from two to three to thirty feet or more in height, some domes that are very high structurally have little or no effect on the surface. Whether this indicates that many domes are antecedent to the surface deposits has not been determined. In any case the means now available for finding domes not marked by a hill or basin on the surface seem to be limited to scant and irregularly developed secondary deposits at the surface, such as the curious "paraffin earth" which is apparently a new compound, though containing possibly both gelatinous silica and some hydrocarbon.

Since the domes are in a flat region underlain by comparatively homogenous sand, silt and clay, it seems more than likely that the salt, dolomite, gypsum, sulphur, compressed clay and possibly igneous rock of the domes would together have a specific gravity noticeably different from that of the country rock in which they occur, and within the range of possibility that the difference could be detected by gravity observations. In other words it seems possible that hidden salt domes, with the immensely valuable pools of oil and gas that are commonly associated, can be discovered through the help of gravity observations, which will thus reduce to a greater or less extent the cost of finding the oil pools.

The intensity of gravity varies with altitude, latitude, topography and the varying density of the materials composing the earth, particularly near the points where the observations are made.

> A mass weighing 200 pounds at sea level at the equator will weigh [on a spring balance] approximately 201 pounds at sea level at either pole. A mass weighing 400 pounds at sea level will weigh approximately 399 pounds at an elevation of 5 miles at the same latitude; and a given mass will weigh less at the top of a sharp mountain peak than if it were at the center of a broad plateau of the same elevation as the peak. . . . The measurement of the force of gravity at a station to be acceptable must not have a probable error greater than one part in two hundred thousand. An actual error of one part in two hundred thousand corresponds to an error of only one one-millionth of a second in the period of oscillation of the pendulum.[1]

The method of observation, consists essentially in determining the effect of gravity on the rate of swing of a pendulum. The instrument "is placed on a solid concrete floor or an especially prepared brick or concrete pier." With the interferometer, vibrations of the case "due to the passing of a team a city block away or a team a mile away are easily detected."

The average probable error in the gravity observations of the Coast and Geodetic Survey is said to be in general about .002 or .003 of a dyne.

> If we assume that the force of gravity at the center of a section [square mile] which is underlain with sand one mile deep at a specific gravity of 2.50 is 980,000 dynes, then if the [cubic mile of] sand were replaced by limestone at a specific gravity of 2.75 the force of gravity would be increased to about 980.005 dynes. Similarly, if the same were replaced by basalt at a specific gravity of 3.00 the force of gravity would be increased to about 980.010 dynes. The change in the force of gravity at the center of the adjacent section due to these changes in specific gravity would be about one fifth as much as in the section affected.[2]

Apparently, if a cubic mile of clay and sand with a specific gravity of 1.80–2.00 immediately underlying the surface were replaced by common salt with a specific gravity of 2.10 or 2.20, the effect on the intensity of gravity might be observable. If a still heavier mass made up of salt, dolomite, igneous rock, etc., having a specific gravity of 2.50 to 2.75 were intruded the rate of swing of the pendulum would be very perceptibly increased. If, however, only a quarter of a cubic mile of the clay and sand were replaced with the lighter or heavier substances, the effect would scarcely be observable, and if the intrusion occurred several thousand feet below the surface it might not be possible to locate the position with the gravity instrument. Other instruments have been devised for measuring the intensity of gravity that do not make use of the pendulum, and it seems within the range of possibility that in time an instrument of some sort will be perfected by which more delicate observations can be made.

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[1] U. S. Coast and Geod. Survey, Spec. Pub. No. 23, pp. 48 and 50, 1916.

[2] Letter to writer from acting superintendent Coast and Geod. Survey, April 4, 1916.

The writer has found but one published statement suggesting the use of gravity anomalies in the search for oil, and this was not intended to apply in the way here outlined. Eötvös,[3] in 1913, suggests that it may be possible to find water, ore, coal, salt, oil and gas by using gravity anomalies. David White[4] has, however, studied the relationships between gravity anomalies and character of rocks.

On account of the slight variations in altitude and latitude in southern Louisiana and Texas and other regions where salt domes occur, it seems possible that a considerable part of the calculations made in connection with the occupation of stations for other purposes may be eliminated. The use of gravity observations in the search for salt domes would then consist essentially in determining at many points the number of beats in a unit of time of a pendulum so constructed and encased as to reduce the friction to the lowest point possible. If the material in many of the domes will perceptibly affect the number of beats then it may be that gravity anomalies can be used profitably in searching for hidden domes, the observations for most points in a county or group of counties being uniform, while at a few points a perceptible departure can be observed. The increasing value of oil and the keen interest in prospecting make it seem possibly worth while to make some practical tests with the gravity instrument on a known salt dome and surrounding country, especially since many wells are being sunk at random in the region. To be sure, some salt domes are known which do not seem to have oil pools, and others are known which have not yet been fully tested, but the number of insufficiently tested domes is rapidly decreasing, and with the keener interest in the search for oil the time will no doubt soon come when it will be profitable to spend a great deal of money searching for salt domes, for they seem to be much more likely to contain oil than the surrounding country.

Eugene Wesley Shaw
U. S. Geological Survey

ANNUAL FIELD TRIP OF THE AMERICAN ASSOCIATION OF STATE GEOLOGISTS

The American Association of State Geologists made a very pleasant and instructive trip through Oklahoma, October 12 to 16. At the winter meeting in Albany, in December, 1916, it was decided to hold the summer field meeting in Oklahoma, and the Oklahoma Geological Survey accordingly made very comprehensive plans for the entertainment of the association.

The declaration of war and the consequent interest of the geologists in war materials lead to the combination of the first part of the field trip with the meeting of the American Institute of Mining Engineers.

After the meeting of the American Institute of Mining Engineers ended at Drumright the

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[3] Eötvös, Roland, Ungarn. Bericht über Arbeiten mit der Drehwage ausgeführt im Auftrage der Kön. Ungarischen Regiergung in den Jahren 1909–1911: Internat. Erdmessung, 17 Allg. Conf., Hamburg, 1912, Beilage *A*, XL., pp. 427–438, 1913.

[4] White, David, "Discussion of Gravity Anomalies from the Stratigraphic Standpoint" (no abstract). Discussed by William Bowie: Washington Acad. Sci. Jour., Vol. 7, No. 10, p. 312, May 19, 1917. Meeting of Geol. Soc. of Washington on March 14, 1917.

State Geologists' Association left the American Institute and continued the excursion outlined by the Oklahoma Geological Survey. The association was fortunate in having with it Mr. A. A. Snietkoff and Ivan O. Goubkin, members of the Russian Commission, and A. Stepanoff, their secretary and interpreter, and also Mr. David White, chief geologist of the U. S. Geological Survey.

The party arrived in Oklahoma City, where they were dinner guests of the Oklahoma Geological Survey. At this dinner President and Mrs. Brooks of the university honored the association with their presence. The next morning the party went to Lawton, where the Businessmen's League conducted them on an automobile trip through the Ft. Sill Military Reservation, Medicine Park and through the Wichita Mountains to the United States Forest and Game Preserve. The hospitality exhibited on this occasion will long be remembered by every one of the party. On the following morning automobiles were again used for a trip through the Lawton oil and gas field, where some new gas wells with enormous capacity have recently been brought in. By courtesy of the owners, the Keys well No. 2 was opened in order that the visitors might have the opportunity of seeing one of the largest gassers ever drilled in the state. The capacity of this well is estimated at 60,000,000 cubic feet per day and the rock pressure is in excess of 1,000 pounds, so large, indeed, that great difficulty is experienced in controlling the well. From this field the trip was continued by automobile through Waurika and Ringling to the Healdton oil field and the Fox gas district. After visiting the many interesting sights of this field the party was taken to Ardmore for the night, and in the evening were the guests of the Ardmore Chamber of Commerce at a concert.

The following morning the Chamber of Commerce provided machines to take the party north of the city into the Arbuckle Mountains. About two miles above Turner Falls the machines left the party and the trip was made on foot down to Turner Falls and across the mountains to Price's Falls, where they were again joined by the machines. The wonderful beauty of the Travertine Falls in this district was enjoyed by all members of the party, and it was particularly enjoyable because of the fact that a new bulletin by the Oklahoma Geological Survey on these phenomena had just been received that morning from the printer. The automobiles then took the party to Davis, where the Santa Fe train was taken for home. The party finally disbanded after dinner at the Harvey House, at Purcell.

A few members of the association stopped over at Norman and visited the State University before continuing to their homes.

W. O. HOTCHKISS,
Secretary

SCIENTIFIC EVENTS

THE LATE DR. RICHARD WEIL

The following minute has been adopted by the board of trustees of the New York Memorial Hospital:

> Dr. Richard Weil, Major in the Medical Reserve Corps, U. S. A., died while on active duty at Camp Wheeler, Macon, Ga., November 19, 1917. By his death the Memorial Hospital loses one of the most highly trained and successful workers of its medical staff, and American cancer research one of its recognized leaders. Since 1906 Dr. Weil has been an active member of the staff of the Huntington Fund, and throughout this period of eleven years he was constantly engaged in the problems of cancer research. His contributions in the field of the serology of cancer and in the general problems of immunity gained for him an international reputation. He was one of the founders of the American Association for Cancer Research, and largely through his efforts was founded the *Journal of Cancer Research*, of which he was editor-in-chief. At the reorganization of the Memorial Hospital in 1913, Dr. Weil assumed the position of assistant director of cancer research and attending physician to the hospital, and in this capacity he labored energetically to establish an efficient organization of the routine and research work of the hospital. In 1915 he resigned the position of assistant director upon his appointment as professor of experimental medicine in Cornell University, but he continued without interruption his experimental work in cancer. Upon the declaration of war he was among the first to offer his services to

the government, and spent the summer at Fort Benjamin Harrison in the Medical Officers' Training Corps. Quite recently he was detailed to take charge of a large military hospital at Camp Wheeler, Macon, Ga., and here in the performance of strenuous military service he fell a victim to pneumonia. During his brief but brilliant career he attained eminence as a devoted laboratory worker, a skilful experimenter, a broadly trained clinician, and a forceful writer, while his untimely death places his name among the first on his country's honor roll in the great war.

MEDICAL INSPECTION OF CAMP WHEELER

MAJOR-GENERAL WILLIAM C. GORGAS, surgeon general of the army, has returned from an inspection trip to Camp Wheeler, Macon, Ga. His report to the chief of staff is in full as follows:

> In my recent inspection of Camp Wheeler at Macon, Ga., I found conditions as had been indicated by reports. There had been a sharp epidemic of measles, some 3,000 cases, and, as always occurs with measles, a certain number of cases of pneumonia. At the time of my visit, there were some 300 cases of pneumonia in the hospital. While the hospital was crowded, the right of way was given the pneumonia cases, and they were being well cared for.
>
> In the past month there have been about 60 deaths from pneumonia. The height of the measles epidemic was passed some 10 days ago, and at the time of my visit the epidemic was markedly on the decline, but the pneumonia does not develop until a week or 10 days after the incidence of the measles.
>
> We can therefore expect a considerable number of deaths from pneumonia.
>
> The camp is well situated and was in generally good condition. I think the reason for the measles affecting so severely this particular camp is the fact that the men came from the surrounding southern states which are sparsely settled and therefore the inhabitants do not, as a rule, have measles in childhood.
>
> A large proportion of the cases of pneumonia were evidently contact cases, and I am anxious on this score, fearing that we may be beginning here an epidemic and septic pneumonia. We have had a few cases of meningitis, a few cases of scarlet fever and some cases of mumps.
>
> Whatever the original cause of the epidemic and the present conditions, all these evils are accentuated by the crowded condition of the camp. The tendency to pneumonia has no doubt been increased by the fact that the men have generally been exposed to the cold weather of the past month with no other protection than their summer clothing. Clothing is now rapidly coming into camp, and about two thirds of the men are supplied with woolen garments.
>
> I recommend that it be insisted upon that all men in the camp have 50 feet of floor space each and, to accomplish this, that such additional shelter be supplied as may be necessary; that no fresh men be brought into the camp until the epidemic has subsided; that an observation camp be established; and that all new men be kept under observation until the main camp is free from infection.

Accompanying General Gorgas were Colonel Dean C. Howard, of the Regular Army, recently health officer at the Canal Zone, where he was in charge of civil sanitation; Major Victor C. Vaughan, Marine Officers' Reserve Corps, professor of hygiene at the University of Michigan, dean of its medical faculty and president of the Michigan State board of health; Major William H. Welch, Marine Officers' Reserve Corps, professor of pathology at John Hopkins University and dean of its school of hygiene; and Major Theodore C. Janeway, Marine Officers' Reserve Corps, professor of medicine at Johns Hopkins.

Steps have already been taken to separate the men to a greater degree. By the use of tents which were held for new men due to be called to the camp and with 1,000 additional tents immediately shipped, the number of men per tent can be reduced from nine to five. As new men come other tents will be provided for them. All the new arrivals will be kept away from men who have been some time in camp to minimize the danger of contagion. This carries out Gen. Gorgas's recommendation that an observation camp be established for new men.

The supplying of sufficient clothing has been delayed by the necessity of equipping first those divisions in northern latitudes and those which have been sent abroad. The men at Camp Wheeler now have a good supply of warm underwear and heavy outside clothing was shipped some days ago. It should be arriving at the camp now, but congestion of railroad traffic has caused some delay in its delivery.

There are over 29,600 men at Camp Wheeler.

THE USE OF THE McKAY BEQUEST TO HARVARD UNIVERSITY

Harvard University can not share the Gordon McKay bequest with the Massachusetts Institute of Technology, according to the decision by the full bench of the Supreme Court which declares invalid the agreement between the two institutions under which Harvard suspends its instruction in applied science and devotes three fifths of the income of the McKay endowment to the maintenance of the engineering departments at the Institute. The decision is on the petition of Harvard to have the court ratify the agreement. It means that Harvard, which abolished the Lawrence Scientific School to merge its scientific courses with those at Technology, will have to reestablish a school of applied science under its administration. The court, in its decision, written by Judge DeCourcy, says:

> We are constrained to instruct the plaintiff corporation that it can not lawfully carry out this agreement between it and the institute, as far as respects the property received by the university under the deeds of trust and the will of Gordon McKay.
>
> In substance the plan agreed upon between Harvard and the Institute of Technology devotes three fifths of the endowment to an engineering school, which is not only located at the institute but is conducted and controlled by the institute instead of by the university. We can not assent to the assertion of counsel that "the school of applied science on the Charles River embankment is a Harvard school, a department of Harvard University."
>
> Education and research in the five branches covered by the agreements are to be transferred from the university to the institute, and there conducted under the provisions of the agreement as part of the latter's curriculum. The Harvard professors associated with those courses shall become members of the faculty of the institute, and the property and equipment which the university may hold for the promotion of instruction in industrial science shall be devoted to the courses so conducted. The faculty which determines the conditions of entrance, prescribes the courses that lead to degrees, largely shapes and carries to practical application the instruction and discipline of the school, and mainly influences the appointment of professors, is the faculty of the institute, notwithstanding that 14 of its 120 members come from the university.
>
> The effective instrument is the deed of trust executed October 30, 1891, and confirmed by a codicil November 5, 1891. McKay was then seventy years of age. He had been a successful manufacturer and inventor of machinery. He was a man of artistic tastes, a lover of music and had traveled extensively in Europe. From 1864 or 1865, for more than twenty years, his home was in Cambridge, near the college yard; he took a leading part in supporting the Symphony concerts in Sanders theater and was brought into friendly relations with many of the college teachers and students. He appreciated the advantages of combining training in the exact sciences with liberal culture in the atmosphere of the university. During all those years there was a close personal intimacy between him and the late Professor Shaler, long connected with the university and appointed dean of the Lawrence Scientific School in 1891; and with the latter McKay discussed his scheme for the disposition of his fortune.
>
> The income of the McKay endowment must be administered according to the intention of the founder, Gordon McKay, even though it be at variance with our views of policy and expediency.
>
> Reading this instrument in the light of the circumstances already referred to it seems reasonably clear from its expressed provisions and implied limitations that Mr. McKay intended that not only the investment of the endowment fund, but the education which his endowment was to make possible should be under the control and direction of the university, its government and administration.
>
> He selected as a trustee to carry out his purpose a great educational institution, one whose ability adequately to carry out his plans he was familiar with, and with whose historic name he desired to associate his own in perpetual memory.
>
> In our opinion this intention of Gordon McKay is not in fact carried out in the agreement in controversy, as we have construed its provisions in their practical operation.

ANNUAL MEETING OF THE AMERICAN ORNITHOLOGISTS' UNION

The thirty-fifth annual meeting of the American Ornithologists' Union was held in

Cambridge, Mass., from November 13 to 16. The election resulted in the choice of the following officers for the ensuing year: John H. Sage, Portland, Conn., *President;* H. W. Henshaw and Dr. Witmer Stone, *Vice-Presidents;* Dr. T. S. Palmer, 1939 Biltmore St., Washington, D. C., *Secretary;* and Dr. Jonathan Dwight, *Treasurer;* the members of the council were all reelected. The single vacancy in the list of fellows was filled by the election of P. A. Taverner; two additions were made to the list of honorary fellows, Dr. A. H. Evans, of Cambridge, England, and W. L. Sclater, of London; and Dr. F. E. Beddard, of London, was elected a corresponding fellow. R. H. Beck, W. S. Brooks, James B. Chapin, Francis Harper, and Winsor M. Tyler, were elected members and 113 associates were added to the rolls.

The public meetings which were held in the Museum of Comparative Zoology were well attended and the program was more varied than usual. Papers were presented on the birds of several distinct parts of the world, including northern Canada, Costa Rica, Nicaragua, British Guiana, Peru, Chile, Falkland Islands, China and Africa. In addition to the regular program the social features of the meeting included an informal reception at the Boston Society of Natural History, the regular subscription dinner, and an outing to the Ipswich sand dunes where the Ipswich sparrow and other characteristic birds were observed. The members also had an opportunity to examine the collections of the Boston Society of Natural History and the Museum of Comparative Zoology, including the celebrated Lafresnaye collection of foreign birds, and to visit some of the historic points about Boston and Cambridge.

The next meeting will be held in New York City.

GENERAL ANNOUNCEMENT OF THE PERMANENT SECRETARY OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE seventieth meeting of the American Association for the Advancement of Science, and the sixteenth of the "Convocation week" meetings, will be held in Pittsburgh from December 28, 1917, to January 2, 1918.

The Council will meet Friday morning, December 28, and each following morning, in the Council Room, Hotel Schenley, at 9 o'clock.

The opening general session of the Association, with address of retiring President Van Hise, on the Economic Effects of the World War in the United States, will be held at 8 o'clock P.M., on Friday, December 28 (not Thursday, as was at one time proposed), in the Carnegie Music Hall, followed by a reception in the foyer, tendered by the University of Pittsburgh and the Carnegie Institute to members of the association and affiliated societies, with accompanying ladies.

Hotel rates, railroad rates, facts concerning affiliated society meetings, and other information will be found in the preliminary announcement.

For all matters relating to the local arrangements, hotel and boarding house accommodations, not explained in the following pages, address Dr. S. B Linhart, secretary, local executive committee, American Association for the Advancement of Science, University of Pittsburgh.

Nominations to membership and letters relating to the general business of the Association should be sent to the Permanent Secretary at Washington. It is strongly urged that each member should at least make an effort to secure the nomination of some desirable new member. Owing to the lateness in the year, those proposed may, if desired, have their membership date from January 1, 1918; but they will be entitled to all privileges at the coming Pittsburgh meeting. The payment of the $8 fee should be mailed to the Permanent Secretary's office, Washington, prior to December 18, so that membership cards and announcement may be mailed promptly, or the member may make payment in person during the meeting-week at the Registration Desk, Main Building, Carnegie Institute.

Official receipts for dues are mailed to members on the same day that their payments reach the office of the permanent secretary. For their own comfort, members are urged to send their dues to the permanent secretary so far in advance of the meeting as possible. In this way they will receive their cards by mail at once and avoid the necessity of waiting in line to make payment at the meeting. Do not forget to bring your white Registration Card to Pittsburgh.

Members who have not previously paid their dues for the Pittsburgh meeting will please call at the office of the permanent secretary, Main Building, Carnegie Institute, after 9 o'clock on Friday, December 28, to receive their members' tickets. The office of the permanent secretary will be used throughout the week for registration purposes. Members will register and receive their badges after paying their dues.

All members of affiliated societies who are not also members of the American Association for the Advancement of Science are earnestly requested to register their names at the desk provided for that purpose in the office of the permanent secretary, in the Main Building, Carnegie Institute, in order that an estimate may be made of the number of persons in attendance at the meetings.

Attention is called to the following rule relating to members' families and other associates:

> Every member of the association shall have the privilege of registering members of his family as *associates* (not including men over twenty-one years of age) by paying the sum of three dollars for each person so registered, and shall receive for them badges which will entitle the holder thereof to such privileges as may be extended to the members generally by the local committee for the meeting.
>
> Members of scientific societies whose meetings are contemporaneous with or immediately subsequent to that of the association, and which are recognized by votes of the council as "affiliated societies," may become associate members for that meeting on the payment of three dollars. They shall be entitled to all the privileges of membership except voting or appointment to office, but their names shall not appear in the list of members printed in the report.

All dues and admission fees must be paid at the office of the permanent secretary, and the annual dues for 1918 should be paid before registering and receiving the association badge and program.

As changes of address in the printed list of members are made only by request of a member, members will please be particular in reporting any changes of permanent address, also the decease of other members, at the office of the permanent secretary.

The register for the Pittsburgh meeting will be open on Friday, December 28, and succeeding days, from 9 A.M. to 5 P.M., in the permanent secretary's office, Main Building, Carnegie Institute.

L. O. HOWARD,
Permanent Secretary, A. A. A. S.

SMITHSONIAN INSTITUTION,
WASHINGTON, D. C.

SCIENTIFIC NOTES AND NEWS

DR. WILLIAM GILSON FARLOW, professor of botany at Harvard University, has been elected a corresponding member of the French Academy of Sciences.

PROFESSOR VERNON KELLOGG has accepted an invitation to give the annual address to the Entomological Society of America, at the annual meeting in Pittsburgh, on December 29.

MR. DOUGLAS STEWART, assistant director of the Carnegie Museum, Pittsburgh, is chairman of the Committee on Scientific Exhibits for the meeting of the American Association for the Advancement of Science in Pittsburgh, December 28, 1917, to January 2, 1918. Those interested in these exhibits are requested to correspond with Mr Stewart.

THE de Morgan medal of the London Mathematical Society has been awarded to Professor W. H. Young, of the University of Liverpool and the University of Calcutta.

SIR J. J. THOMSON has been nominated by the council of the Royal Society for reelection as president. Other officers nominated by the council are as follows: *Treasurer,* Sir A. Kempe; *Secretaries,* Professor A. Schuster and Mr. W. B. Hardy; *Foreign Secretary,* Professor W. A. Herdman; *Other Members of the Council,* Dr. H. K. Anderson, Sir G. T. Beilby, Professor G. C. Bourne, Professor A.

R. Cushny, Dr. M. O. Forster, Professor P. F. Frankland, Dr. J. W. L. Glaisher, Professor B. Hopkinson, Mr. J. H. Jeans, Professor W. H. Lang, Major H. G. Lyons, Dr. W. H. R. Rivers, Professor C. S. Sherrington, Professor R. J. Strutt, Mr. J. Swinburne and Professor W. W. Watts.

The July number of the *Observatory* contained a letter from Professor H. G. v. de Sande Bakhuyzen explaining the present position of the association, whose convention expired on December 31, 1915, the majority of the belligerent states having refused to continue their support under the existing convention. The death of General Bassot, the president; of Dr. Backlund, the vice-president, and of Professor Helmert, director of the Central Bureau, has left Professor H. G. v. de Sande Bakhuyzen the sole survivor of the committee of the International Geodetic Association. He had, in December, 1915, appealed to the members of the permanent commission of the association in the neutral states of Europe and in the United States, and had obtained from them sufficient support to keep the association alive until a date two years after the conclusion of peace. M. Raoul Gautier, of Geneva, has been elected president, and General Madsen, of Copenhagen, vice-president. Professor Bakhuyzen retains the office of secretary.

Dr. Richard M. Pearce, professor of research medicine, University of Pennsylvania, has been made director of the recently established bureau of medical service of foreign commissions of the American Red Cross.

Dr. Reston Stevenson, assistant professor in charge of physical chemistry in the College of the City of New York, has been commissioned a captain in the Sanitary Corps of the Army. As one of a group of five selected men he will shortly go to France, where he will be assigned to a French laboratory for special work, preliminary to its extension among the other chemists attached to the U. S. Army.

At the University of Michigan leaves of absence have been granted to Professor John D. Rue, who becomes captain in the Ordnance Officers' Reserve Corps; to Dr. Peter Field, who is captain in the United States Coast Artillery; to Dr. R. A. McGarry, instructor in dermatology, who leaves to take up military service; to Dr. Orlow B. Snyder, instructor in anatomy; Winthrop R. Wright, who has accepted a temporary position in connection with War work in the Bureau of Standards at Washington; and Assistant Professor C. W. Cook, of the department of geology, now engaged in special advisory work with a large steel corporation.

Professor L. D. Rowell, of Purdue University, has been commissioned a captain in the Engineer Officers' Reserve Corps and is now in active duty as the recorder of the Board of Engineer Troops, Washington, D. C.

Guy R. McDole, assistant in soils in the University of Minnesota and formerly research assistant in agricultural chemistry in the University of Nebraska, has enlisted in the Gas and Flame Regiment (Thirteenth Engineers), and has left for his new work.

Mr. Daniel Willard, of Baltimore, trustee of Johns Hopkins University and chairman of the advisory commission of the Council of National Defense, has been appointed to serve as chairman of the War Industries Board.

Professor George B. Thomas, of Colorado College, is on a year's leave of absence, during which time he will work with the Western Electric Company along lines of interest to the military authorities.

Mr. John W. Gilmore, professor of agronomy in the University of California, is carrying on a wheat campaign in California—handling the problems of proper seed, varieties for different regions, time of planting and related topics. Mr. Charles F. Shaw, professor of soil technology in the university is in charge of the soil survey in California, and is carrying on a state campaign for increasing the acreage of wheat lands now in pasture or idle.

Professor W. S. Ford, of Cornell University, who had charge of the senior electrical laboratory work, has left to accept a position as superintendent of power with the Vacuum Oil Company, Paulsboro, N. J.

Professor H. P. Barss, plant pathologist of the Oregon Experiment Station, presented an address before the California State Horticultural Commission on November 19, on the bacterial gummosis of stone fruits with special reference to the serious outbreak along the Pacific coast this year.

WE learn from *Nature* that at the annual general meeting of the London Mathematical Society, held on November 1, the following were elected as officers for 1917–18: *President,* Professor H. M. Macdonald; *Vice-Presidents,* Professor H. Hilton, Professor E. W. Hobson, and Sir J. Larmor; *Treasurer,* Dr. A. E. Western; *Secretaries,* Dr. T. J. I'A. Bromwich and Mr. G. H. Hardy; *Other Members of the Council,* Professor W. Burnside, Dr. S. Chapman, Mr. A. L. Dixon, Miss H. P. Hudson, Mr. A. E. Jolliffe, Mr. J. E. Littlewood, Professor A. E. H. Love, Major P. A. MacMahon, and Professor J. W. Nicholson.

MR. W. DUDDELL, F.R.S., past-president of the Röntgen Society and of the Institution of Electrical Engineers, died on November 4, aged forty-five years.

SIR DAVID C. MCVAIL, professor of clinical medicine in St. Mungo's College, Glasgow, from 1889 to 1906, and author of contributions to physiology, died on November 4 at the age of seventy-two years.

THE deaths are also announced of Dr. J. Rambousek, professor of factory hygiene at the University of Prague, and an authoritative writer on industrial poisonings; of P. Malerba, professor of physiological chemistry at the University of Naples, and of M. E. Huet, one of the pioneers in electrology in France.

IN connection with or in response to the call of the President for volunteers, the attention of all technical men, *i. e.*, men skilled in any line of science or mechanical or electrical or chemical or ordnance or explosives or mining or ship-building or railroad or motors or metallurgy or building of aeroplanes or water supply or sanitation, etc., is especially invited to the need of the Army for such men—aged eighteen to forty—in sundry branches of the technical troops. Information may be obtained from Major J. E. Bloom, U. S. A., 266 Market Street, Newark, N. J.

A NUMBER of American military surgeons arrived in England during the fortnight prior to September 22, and took up duty in a number of hospitals in London and the provinces, and also in France, to which country about fifty of the seventy-five had been sent. These will only attend the military patients in the institutions to which they have been assigned, and have been so allotted that a number of doctors may be released for work among the civil population. There are now over 900 American medical men serving with the British forces in Great Britain and France.

A JAPANESE medical corps of one hundred men has gone to Rumania to help in the effort to control the epidemic of typhus fever in that country. The corps is divided into three sections—internal diseases, surgery and epidemics—each with its own chief. The headquarters of the corps will be at Jassy.

WILLARD E. CASE, of Auburn, N. Y., has made a gift to the New York Electrical Society the amount of which has not yet been made public, but which is sufficient to defray all the liabilities of the society and leave a substantial sum for the carrying on of its special work.

THE fifth annual Pennsylvania Welfare and Efficiency Conference was held in the House of Representatives, Harrisburg, on November 21 and 22. These conferences are held annually for the purpose of stimulating discussions on the problems of industries and labor, with special reference to the reduction of the enormous number of diseases and deaths, and the numerous industrial accidents. The fifth conference of industrial physicians and surgeons was held at Harrisburg, on November 20. At the morning session the medical and surgical problems of the staff of the largest industries representative of Pennsylvania were considered, and in the afternoon the question of industrial diseases was taken up.

CHILDREN in various parts of Great Britain are now busy collecting the horse chestnuts required for the manufacture of war munitions. The nuts have ripened more quickly in some districts than in others, and in some parts of

London the collection is well forward. It should again be pointed out that every ton of nuts gathered means a saving of half a ton of grain. Present indications are that at least 25,000 tons of nuts will reach the Ministry of Munitions, but this is only about one eighth of the estimated crop for the country.

UNIVERSITY AND EDUCATIONAL NEWS

A bequest of $200,000 is left to Yale University by the terms of the will of the late Richard P. Sewell of Boston.

H. P. Wood, head of the department of electrical engineering at the Georgia School of Technology, Atlanta, Ga., has been appointed president of the Academic Board of the United States Army School of Military Aeronautics, which has been established at the Georgia School of Technology.

Professor J. F. Wilson, who during the past year was professor of electrical engineering at Queen's University, Kingston, Ontario, has been appointed assistant professor of electrical engineering at the University of Southern California, Los Angeles.

Dr. John Edward Marr, F.R.S., fellow of St. John's College since 1881, university lecturer in geology at Cambridge University, has been elected to the Woodwardian professorship of geology in succession to the late Professor Hughes.

DISCUSSION AND CORRESPONDENCE

METHODS FOR PREPARING ANIMAL MATERIAL TO BE DISSECTED

Possibly the most common fixing and preserving fluid used for dissecting material is formalin. It is relatively inexpensive and especially convenient for collecting expeditions where a concentrated fluid is desirable. Animals preserved in it have rigid joints, however, and every one is familiar with the disagreeable characteristics of such material during dissection. Alcohol is much better from the standpoint of the dissector, but it has limitations when used alone.

Some of the "embalming fluid" mixtures used in preparing human cadavers for dissection are also splendid for smaller animals. Those containing phenol, alcohol and glycerine with no formalin give relatively flexible joints and pliable tissues. They also render the material resistant to a large amount of drying in the open air of a laboratory during dissection. Phenol is a relatively non-volatile antiseptic, and glycerine is very effective in preventing drying. Alcohol counteracts the action of the phenol in the solution, on the hands of the dissector. A good and much used solution consists of equal parts of phenol, alcohol and glycerine. Another less expensive fluid with arsenic and considerable water added to the above was described by Dr. W. C. Lusk some years ago[1] with an excellent discussion of principles involved in preparing cadavers for dissection.

As penetration by such fluids is slow, the mixture should be injected through some large artery, a *femoral* or *carotid* in the case of mammals. Small animals may be placed in solutions of about 80 per cent. alcohol in water when it is not practicable to inject them. In such cases, the usual practise of making a slit, at least in the ventral abdominal wall, should be followed. After all the tissues have been fixed, the material may be removed to a container which holds an "embalming fluid," such as I have mentioned, much diluted with water. Ten or more parts of water to one of the "embalming fluid" may be used. In fact, I have kept material which had already been thoroughly fixed in either formalin or alcohol, for several years in a solution consisting of water with 1 to 2 per cent. of phenol and 5 to 10 per cent. glycerine, with or without a little alcohol. Single specimens thus preserved have been used in dissection for many months without deterioration, so long as they were not kept out of the solution for more than a few hours or so at a time.

It is customary in human anatomy to leave cadavers on the dissecting tables for months without soaking. The glycerine in their tissues is wonderfully effective in checking drying. Nevertheless, unless the atmosphere of the room is very moist a good deal of drying does occur. According to my experience, it is worth the trouble to give even such large bodies as the human, as much soaking occasionally as is practicable, in such a solution as I have just described. This should be done between class periods, at least twice a week, when the air of the room is at all dry.

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[1] *Anat. Record*, Vol. 8, No. 1.

When material comes to my hands already filled with formalin, I soak it in running water, for a number of hours, according to its size, to get rid of the formalin, before transferring it to a phenol-glycerine solution.

Material which has been thus prepared with a phenol-glycerine solution can be stored or shipped in airtight wrappings with no surrounding solution. In an important article on methods for preserving and storing cadavers Keiller[2] has described methods for preparing wrappings.

I have adopted the practise of shipping material, which has been thoroughly soaked in the dilute embalming fluid described in this article, in packages well wrapped and packed in excelsior. No fluid except that in the specimen is needed for a number of weeks, even in summer, if the packing is well done. There is much economy in weight, and expensive containers are not needed.

In some medical schools, cadavers are stored in airtight chambers with no fluid except for a dish of alcohol which keeps the atmosphere of the chamber saturated with alcohol fumes. This is the best of all storage methods that have come to my attention, for properly embalmed bodies, and it works well with other large vertebrates. I have found it successful in a warm climate, and I have never heard any criticism of the method by people who have tried it.

Much trouble from drying of material in the dissecting room can be avoided by keeping the air of the room very humid. Professor S. W. Ranson, Northwestern University Medical School, has called my attention to a device which he has found efficient in maintaining a humid atmosphere and which eliminates the drying troubles. This is the "Steamo Air Moistener," which can be obtained from "The Air Moistener Co.," 28 North Market St., Chicago. It is attached to steam radiators of various types. Directions are furnished for maintaining any desired percentage of humidity.

R. M. STRONG

ANATOMICAL LABORATORIES,
VANDERBILT UNIVERSITY MEDICAL SCHOOL

SCIENTIFIC BOOKS

Physical Chemistry of Vital Phenomena for Students and Investigators in the Biological and Medical Sciences. By J. F. MCCLENDON, Assistant Professor of Physiology in the University of Minnesota. Princeton University Press, 1917.

In this concise book of less than 200 pages of text Professor McClendon describes and discusses briefly some of the more recent applications of physical chemistry to the analysis of vital phenomena. The field, although no longer new, is very large and calls for much further investigation; hence finality is scarcely possible at present, and the author describes his purpose as largely practical and tentative: "to develop a tool for physiological research," rather than to produce a systematic treatise on the subject. The space assigned to the different topics under discussion is very unequal; many of these are presented in the barest summary, with little attempt to reconcile conflicting statements or to reach unifying conclusions; while others, particularly those in which the author's own chief researches have been made, are treated in considerable detail. The book is intended for advanced students and presupposes more than elementary biological and chemical knowledge in the reader; condensation is carried to an extreme, and in many places one receives the impression of a succession of abstracts, in which both the selection and the omission of material seem arbitrary. In the later chapters, which deal with the more specifically biological topics (amœboid movement, tropisms, cell-division, fertilization, muscular contraction, oxidation, production of light and heat), the space is quite insufficient for adequate discussion, and the account is condensed to a bare outline of the facts and points of view which the author considers important. At the end there is an appendix on the general chemical composition of organisms, followed by a large and varied literature list and an index of topics with the names of the authors of the chief papers. Much of the book thus forms a summary of recent research, and will be valuable to those desiring a record of progress in this field and a guide to the literature of its various departments.

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[2] *Philadelphia Medical Jour.*, December 29, 1900.

The *most original chapters* are those relating to the determination of hydrogen-ion concentrations and the electromotor and osmotic properties of partitions, and here there is much that is ingenious, independent and suggestive. The author's improved methods for determining the H-ion concentration of blood are described in detail, with figures of apparatus and a useful chart for converting potentials into H-ion exponents. The use of indicators and buffer mixtures is also explained, and many valuable data are given in convenient form. The account of semi-permeable and porous partitions is especially timely and interesting; the phenomena of membrane-potentials, negative osmose and cell-permeability are described, and their relations to the physiological processes of secretion, absorption and stimulation are discussed in a clear and definite manner. The author supports the view that the bioelectric variations of potential are primarily the expression of variations in the osmotic and hence the electromotor properties of the protoplasmic surface-layers or plasma-membranes. Agents like salts, anæsthetics and cytolytic substances are regarded as producing their characteristic effects by modifying the condition of the plasma-membranes.

As a whole the book exhibits the defects as well as the merits of its extreme brevity and condensation. The author evidently wishes to be as concise as possible, and largely for this reason his discussion and statements of fact frequently appear dogmatic and lacking in much-needed qualifications. Certain explanations are incomplete or otherwise open to criticism. Thus to regard negative osmose as essentially a case of electrical endosmose seems inaccurate; in true electrical osmose both the solution and the porous partition are interposed as parts of an electrical circuit, and the energy for the transport is derived from a battery or other external source; while in negative osmosis the water passes spontaneously through the porous partition from the more concentrated to the more dilute solution. Certain diffusion processes offer a closer analogy; recent investigation has shown that when the partition consists of negatively charged material like porcelain negative osmose occurs in the case of those electrolytes whose anions diffuse more rapidly than their cations; and it seems preferable to regard the positively charged layer of water adjoining the surfaces of the pores as acting like a layer of cations and as being carried after the rapidly diffusing anions by electrostatic attraction. The phenomenon seems indeed to afford further evidence of the hydration of ions in solution. Exception may also be taken to the following statements: suspensoids do not exert osmotic pressure (p. 72); monovalent and bivalent cations are antagonistic to each other in the precipitation of colloids (p. 77); surface-active substances are repelled by water molecules (p. 66); in anæsthesia adsorption is at the basis of the whole matter (p. 140. N. B.: this seems contradicted by the positive temperature-coefficients of narcosis with chloral and alcohol as observed by Meyer); the sperm need only scratch the egg-surface to make it segment (p. 158); local reduction of surface-tension produces protrusion of the affected surface (p. 148). This last statement especially needs *qualifying*; it can be true *only* when the surface-tension equilibrates some other force (such as gravity), which of itself tends to cause outflow or protrusion of fluid. The force of surface-tension acts tangentially, hence the surface-layer of fluid must always tend to be drawn toward the regions where the tension is highest; this removal of fluid from the areas of lower surface-tension must (unless otherwise compensated) cause there *depression* instead of protrusion, as seen for instance in the case of a layer of water to which ether or alcohol is locally applied. In the case of any curved surface, *e. g.*, of a suspended drop of fluid, the tangentially acting force due to surface-tension must similarly tend to draw the surface-fluid away from any area where the tension is locally lowered; for geometrical reasons this lateral traction is necessarily greater than the externally directed force acting on the surface-fluid at the same area—due to the radial component of surface-tension which compresses the drop and tends to cause outflow at that area; hence in this case also the surface-layer of fluid will tend to be withdrawn from regions of lower and heaped up at regions of higher surface-tension. If the drop is in contact with a solid, such displacements may by reaction cause movements of the drop as a whole. The author's account of the mechanics of amœboid movement and cell-division needs to be reconsidered, since he assumes throughout that protrusion or outflow always takes place at regions of lowered surface-tension.

The whole subject, however, is full of debatable questions, and in his preface the author expressly defers judgment upon most of these, urging that the present need is for further investigation rather than for theoretical discussion. Most of us will readily grant this, and it is as an aid to investigation that the present manual will find its chief usefulness.

The reviewer feels bound to point out that the book suffers greatly from carelessness in composition and proofreading. The responsibility for this is not the author's alone. A University Press should be careful to maintain high standards in such matters.

Ralph S. Lillie

THE PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

The seventh number of Volume 3 of the *Proceedings of the National Academy of Sciences* contains the following articles:

The Cayleyan Curve of the Quartic: Teresa Cohen, Johns Hopkins University.

A Search for an Einstein Relativity-Gravitational Effect in the Sun: Charles E. St. John, Mount Wilson Solar Observatory, Carnegie Institution of Washington. A series of observations stretching over several years indicates that the Einstein effect does not exist.

Triads of Transformations of Conjugate Systems of Curves: Luther Pfahler Eisenhart, department of mathematics, Princeton University.

The Molecular Weights of the Triarylmethyls: M. Gomberg and C. S. Schoepfle, Chemical Laboratory, University of Michigan. After discussing factors influencing dissociation and the relation between dissociation and the nature of the aryl groups, seven triphenylmethyls are investigated in detail and various inferences are drawn from the graphs of their dissociations against their concentrations.

Sex-Determination and Sex-Differentiation in Mammals: Frank R. Lillie, department of zoology, University of Chicago. Discussion of the results of studies of the anatomy of twenty-two fetal free-martins ranging in size from 7.5 to 28 cm. Sex determination in mammals is not irreversible predestination; with known methods and principles of physiology we can investigate the possible range of reversibility.

The Crystal Structure of Magnesium: A. W. Hull, Research Laboratory, General Electric Company, Schenectady. The structure is analyzed by means of X-ray.

The Structure of High-Standing Atolls: W. M. Davis, department of geology, Harvard University. Attention is drawn to the relation of atoll limestones to their supposed foundation of volcanic rocks. The relative merits of the glacial-control theory and of Darwin's theory are discussed.

Studies of Magnitude in Star Clusters, VII. A Method for the Determination of the Relative Distances of Globular Clusters: Harlow Shapley, Mount Wilson Solar Observatory, Carnegie Institution of Washington. The median magnitude of short period variables is constant in each cluster and may be used to determine the distance of the cluster which, with one or two exceptions, is found to be greater than 30,000 light-years.

The Principal Axes of Stellar Motion: H. Raymond, Dudley Observatory, Albany, New

York. Three principal axes are determined along which the various groups of stars show markedly unequal motion.

The eighth number of Volume 3 of the *Proceedings of the National Academy of Sciences* contains the following articles:

Relation of Preferential Motion and of the Spectral-Class and Magnitude Velocity Progressions to Proper Motion: C. D. Perrine, Observatorio Nacional Argentino, Córdoba.

Growth of Isolated Sporophytes of Anthoceros: Douglas Houghton Campbell, department of botany, Leland Stanford University. The young sporophyte of *Anthoceros Pearsoni*, separated from its association with the gametophyte, is capable of limited growth in length and is able to mature normal spores and elaters from the young sporogenous tissue.

The Mesa Verde Types of Pueblos· J. Walter Fewkes, Bureau of American Ethnology, Washington, D. C. A morphological study of Far View House and other types of prehistoric buildings.

A Determination of the Ratio of the Specific Heats of Hydrogen at 18° and — 190° C.: Margaret C. Shields, Ryerson Physical Laboratory, University of Chicago. The value 1.4012 closely in accord with kinetic theory and different from previous determinations at 18° C. is obtained; the value 1.592 is found at — 190° C.

Note on the Coefficient of Total Radiation of a Uniformly Heated Enclosure: W. W. Coblentz, Bureau of Standards, Washington, D. C. The value 5.722×10^{-12} is found by direct measurement and agrees with that calculated by Millikan on the basis of his values for *h* and *e*.

The Development of a Source for Standard Wave-Lengths and the Importance of their Fundamental Values· Charles E. St. John and Harold D. Babcock, Mount Wilson Solar Observatory, Carnegie Institution of Washington. It is necessary to examine for pole effect; the problem of wave-length determination is not one of routine but one for real investigation.

On the Presence of Albumoses in Extracts of the Posterior Lobe of the Hypophysis Cerebri: John J. Abel and M. C. Pincoffs, Pharmacological Laboratory, Johns Hopkins University. Secondary albumoses and possibly peptones were found to be present in all the therapeutically used extracts of the posterior lobe of the hypophysis cerebri that were examined. The "Hypophysin" of the Farbwerke-Hoechst is not, as claimed for it, a solution of the isolated active substances of the pituitary gland but a mixture of albumoses with varying and unknown amounts of active and inactive constituents of the gland.

On the Rôle of the Thymus in the Production of Tetany· Eduard Uhlenhuth, Rockefeller Institute of Medical Research, New York. It would seem that thymus contains the substances which cause tetany and secretes them into the body from which they are removed by the parathyroids. Extirpation of the latter would thus cause tetany.

Evidence of Assortive Mating in a Nudibranch: W. J. Crozier, Bermuda Biological Station for Research, Agar's Island, Bermuda. Mating pairs of the nudibranch *Chromodoris zebra* are found to exhibit a rather high degree of correlation between the sizes of the two members. This is due to assortive mating, which may constitute an important influence tending to increase the numbers of larvæ.

Coral Reefs of Tutuila, with Reference to the Murray-Agassiz Solution Theory: Alfred Goldsborough Mayer, Department of Marine Biology, Carnegie Institution of Washington.

National Research Council: Suggestions relating to the new National Army by the Anthropology Committee of the National Research Council; First Report of Committee on Botany; Meetings of the Executive Committee.

Notices of Biographical Memoirs.

EDWIN BIDWELL WILSON

MASSACHUSETTS INSTITUTE OF TECHNOLOGY,
CAMBRIDGE, MASS.

SPECIAL ARTICLES

A RELATION OF ATOMIC WEIGHTS TO ATOMIC NUMBERS, AND A SUGGESTED STRUCTURE OF ATOMIC NUCLEI

THE writer has plotted, for all the elements, ratios of atomic numbers to the corresponding atomic weights against square roots of atomic weights. Although the values for successive elements vary somewhat irregularly, if averages are taken for successive groups of ten or twelve elements each it appears that there exists an approximate general linear relation of the form

$$\frac{N}{W}=0.520-0.0088\sqrt{W}. \qquad (1)$$

N is the atomic number, and W is the atomic weight. The average deviation in N/W from this straight line, regardless of sign, is 0.008. Hydrogen alone was not included in this average.

The relation between N/W and any other power of W, such as $W^{\frac{1}{3}}$ or $W^{\frac{2}{3}}$, is not so nearly linear. Furthermore, if values of N/W are plotted against $\sqrt{W}$ for the odd-numbered and even-numbered elements separately, it is found that a number of curious and nearly exact linear relations exist. Unless these are accidental, equation 1 must express no mere empirical relation, but an actual tendency of atoms.

If atoms have the structure called for by Rutherford's theory, equation 1 must represent a property of the atomic nucleus. If the nucleus is built up of positive and negative electrons, equation 1 can be accounted for if it has a surface shell of positive charge and a volume distribution of negative charge. The values of the coefficients in (1) seem to indicate that the negative electrons in the *nucleus* are packed together like solid spheres; to each negative electron on the surface of the nucleus two positive electrons are attached, on the average. (A positive electron is very much smaller, and hence much more massive, than a negative electron. This is a common assumption in electron theory.) If the number of positive electrons (hydrogen nuclei) in the nucleus is p, and if p is numerically equal to W, then n, the number of negative electrons in the nucleus, is $0.480\ W+0\ 0088\ W^{\frac{3}{2}}$. (It was this three to two ratio of the exponents of W that suggested the assumed structure of the nucleus.) The first term in the equation just given may be supposed to equal the number of negative electrons in the surface layer of the nucleus; then the second term is the number of negative electrons crowded inside. The latter are held together by the external positive shell; it is assumed that this shell tends to contract, perhaps under electromagnetic forces.

In very heavy atoms the number of negative electrons inside the nucleus is so large that they can not be held together by the positive contractile shell against their mutual repulsions. Hence there is an upper limit to atomic weights, and immediately below this limit atoms are unstable.

The nucleus-model described also is capable of illustrating isotopism. Those elements which have atomic weights not whole numbers may, as has been suggested by Harkins and Wilson,[1] each be a group of isotopes—in which case their atomic weights are averages. (This suggestion was first made by Soddy.) For those atomic weights at which the number of negative electrons inside the nucleus increases by unity one might expect that two stable systems could exist. Such atomic weights, as calculated by the equation for n given above, are 23, 37, 49, 59; for these values the number of negative electrons inside the nucleus is 1, 2, 3, 4, respectively. These values of W, then, should be critical values near which isotopes can exist most readily. It is at least interesting to note that, of the four atomic weights less than 60 which differ from integers by more than 0.16, the values of three are 24.32, 35 46, 58.68 (Mg, Cl, Ni), while $\mathrm{Si}=28.3$. It is known, moreover, that isotopes occur at neon, with atomic weights 20 and 22.

The atomic weights of elements heavier than nickel show no tendency to approximate to whole numbers, according to Harkins and Wilson. This is to be expected; because for those elements the number of negative electrons inside the nucleus increases more rapidly with the atomic weight, so that almost every heavy element is near a "critical" value of W.

John Q. Stewart

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Princeton University

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[1] Harkins and Wilson, *J. Am. Chem. Soc.*, XXXVII., pp. 1383–1396, 1915.

A NOTE ON THE AEROBIC CULTURE OF ANAEROBES AT HIGHER TEMPERATURES

A POSSIBLE inverse relation between the temperature and oxygen tension requirements of bacteria has been indicated by Rabinowitch[1] who showed that the minimum temperature requirement of certain supposedly ortho-thermophilic organisms refusing to grow aerobically below 50° C. could be reduced at least to 37° C. by anaerobic culture. Her results account for the finding of thermophilic bacteria as parasites in the human intestine by MacFadyen and Blaxall.[2]

We have had no occasion to confirm the work of Rabinowitch as to the anaerobic growth of thermophilic aerobes as lower temperatures but we have taken advantage of the opportunity afforded in a collection of obligative anaerobes to test the converse possibility, that is the aerobic growth of anaerobes at a higher temperature. A successful result would perhaps have provided a simple means of surface culture for purposes of isolation in certain cases but the results were clearly in the negative.

It does not matter for this purpose that some of these cultures are as yet incompletely identified. The list, showing sources and the identity of the known forms, is to be published shortly in the *Journal of Bacteriology* in a paper describing our work on the inhibitory action of gentian violet and its application in preventing spurious presumptive tests due to these organisms in the bacteriological examination of water. Cultures of *B. botulinus*, *B. tetanus*, *B. chauvei*, *B. œdematis maligni* and the Ghon Sachs bacillus, were included among the twenty-one. All were free from ærobic contamination, as shown by tests on agar slants at 37° C. although we can by no means be certain that some of the unidentified cultures do not consist of more than one species of anaerobic microorganism.

Media containing 1 per cent. glucose, 1 per cent. peptone and 3 per cent. agar were used both for the anaerobic controls inoculated as shake cultures for incubation at 37° C., and the ærobic tests slanted for streak inoculation and incubation at 54° C., in a constant temperature acetone bath. Three per cent. agar was necessary to withstand the latter temperature for the period of the test, fifteen days. Three separate trials were made as follows: In the first, subcultures were made from stock cultures several days old in deep sterilized beef brain. These could not be considered certainly negative due to the resemblance of the transferred brain to surface growth. In the second trial, subcultures were made from 24-hour glucose broth cultures in the constricted tube and marble device for anaerobiosis.[3] Nothing developed on the surface of the slanted agar incubated at 54° C. which could be considered a bacterial growth. This test was repeated with identical results.

In a fourth test, 24-hour glucose broth cultures in constricted tubes were transferred in quantities of 1 c.c. per tube to melted glucose 2 per cent. agar at 42° C. and hardened in the upright position as shake cultures. It was thought that if the premise of this study were true, the greatest growth should occur nearer the surface in the test at 54° C. than in the control incubated at 37° C. But no growth occurred aerobically or anaerobically at 54° C. This test was duplicated in method and results.

The controls at 37° C. gave vigorous growth within 48 hours in every case as evidenced by the distinct and characteristic colonies or opacity and all but four produced abundant gas. The freedom of the control tests from ærobic contamination was also proven by failure of growth on plain agar subplants at 37° C.

LILLIAN JORDAN ELLEFSON,
IVAN C. HALL

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[1] Rabinowitch, "Ueber die thermophilen Bakterien," *Zeitschr. f. Hyg.*, 1895, XX., 154.

[2] MacFadyen and Blaxall, "Thermophilic Bacteria," *Jour. Pathology and Bacteriology*, 1896, III., 87.

[3] Hall, "A New Aerobic-Anaerobic Culture Tube," Univ. of Calif. Pub. in Pathology, 1915, II., 147.

BOSTON MEETING OF THE AMERICAN CHEMICAL SOCIETY. II

FERTILIZER DIVISION

J. E. Breckenridge, *Chairman*

F. B. Carpenter, *Secretary*

A new fertilizer: ALFRED H. COWLES and ALFRED W. SCHEIDT. Mr. Cowles referred to a paper read by him before the World's Congress of Chemists in 1912 entitled "Alumina, hydrochloric acid, caustic alkalis and cement by a new process from salt, clay and lime" and explained that a product of that process that he had been intended to convert into cement, has proven itself of greater value as a fertilizer than calcium hydrate. This increased value being due to a discovery made by him that silica in soluble form when either added to the soil by itself or added to the soil as a calcium silicate proved itself to be an essential fertilizer. He explained why clay and zeolitic minerals in the soil would lock up in insoluble form silica when added to the soil in the form of soluble alkali silicates, while the silica would not be thus locked up or bound in insoluble form when added as a soluble type of silica or as an alkali earth silicate. Mr. Cowles gave the quantitative results of a very large number of experiments showing very large gains in luxuriance of growth in a great majority of the plants experimented with, thus confirming the discovery made by Mr. Cowles and his theoretical explanation of the same.

Potash production in United States: H. A. HUSTON. The American production for 1916 was 3.6 per cent. of the imports in 1913. The agricultural effect of impurities in some of the potash from American sources is mentioned.

The synthesis of ammonia by the Haber process: R. O. E. DAVIS and HARRY BRYAN. The use of a catalytic reagent to bring about the union of hydrogen and nitrogen under pressure and at increased temperature is the fundamental idea underlying the Haber process. About one third of the ammonia used in Germany at present is reported to be produced by this method. This is a preliminary report of the study of the process undertaken in the laboratories of the Bureau of Soils, U. S. Department of Agriculture. The apparatus devised for the work is described. This consists essentially of a heating chamber containing the catalytic reagent through which the mixture of hydrogen and nitrogen is passed, a condensing chamber for the removal of the ammonia formed by liquefaction and a circulating pump for the return of the non-combined gases to the reaction chamber. Granular iron reduced by hydrogen is one of the best and most convenient catalyzers.

Effect of fertilizers on composition of strawberries: H. A. HUSTON. Experiments on six varieties of strawberries. Analyses are given showing the effect of nitrogen, phosphoric acid and potash on the density of the juice and on the percentage of acid, invert sugar and sucrose.

The recovery of potash as a by-product in the cement industry: WILLIAM H. ROSS and ALBERT R. MERZ. Analysis of samples of raw mix and of cement from 113 cement plants in the United States and Canada shows that the potash in the raw mix varies from 0.20 to 1.16 per cent., and that the percentage of potash volatilized in the different plants varies from 24.5 to 95.9 per cent. From the results thus obtained it has been calculated that the potash escaping from the kilns of these plants ranges from 0.35 to 5.14 pounds per barrel of cement produced, with an average for the plants of this country of 1.93 pounds. On the basis of an average production of 90,000,000 barrels, the total potash escaping from the cement plants of this country amounts to about 87,000 tons annually. It has been demonstrated commercially that 90 per cent. of the potash escaping in the dust is recoverable, and from experiments made in this laboratory it would appear that 95 per cent. of the recoverable potash is, or may be made, available. The recoverable potash in the cement industry therefore amounts to approximately 78,000 tons and the available recoverable potash to 75,000 tons, or to 71,000 tons when plants losing less than 1 pound of potash per barrel of cement are omitted.

DIVISION OF AGRICULTURAL AND FOOD CHEMISTRY

T. J. Bryan, *Chairman*

Glen. F. Mason, *Secretary*

The influence of season upon the deterioration of food samples: C. A. BROWNE. The influence of season upon the deterioration of raw sugar and butter-fat is discussed. The deterioration of sugar is due to microorganisms, among the most active of which are the budding fungi, such as the Torulæ and Moniliæ, which exert their activity only when the temperature maximum is above 20°

C. This temperature for New York City is from about May fifteenth to October first; from October to May deterioration is quiescent. The deterioration of butter-fat is not due to microorganisms but to auto-oxidation, in which the unsaturated fatty acids act as oxygen carriers. The process is most active for samples exposed to daylight between March and September, when there is a gain in weight; from September to March there is a loss in weight due to volatilization of decomposition products. Chemical action of light, which is greatest about June twentieth, is a pronounced factor in auto-oxidation, although temperature and humidity also play an important part.

DIVISION OF WATER, SEWAGE AND SANITATION

E. H. S. Bailey, *Chairman*

H. P. Corson, *Secretary*

The diffusion of sea water in the Puget Sound and Lake Washington Canal: E. VICTOR SMITH and THOS. G. THOMPSON. The canal was constructed between Puget Sound and Lakes Union and Washington to give a fresh-water harbor to Seattle. A dam built to control the flow of water during the cutting of the canal was swept away twice, permitting sea water to enter Lake Union. Three years after the second breaking of the dam this lake showed a chlorine content varying from 5,200 parts per million at the bottom, 50 feet, to 17 parts at the surface. Six months later tests showed a decided reduction of chlorine in the upper 40 feet of Lake Union. The difference is due to the inflow of fresh water from Lake Washington and control of tide-water by the lock system. From considerable data authors conclude that an apparently efficient means has been introduced by the government engineers which will prevent the diffusion of sea water into the fresh-water lakes.

On the bactericidal efficiency of soap solutions in power laundering: H. G. ELLEDGE and W. E. MCBRIDE. An investigation of the above mentioned subject conducted by the Mellon Institute in behalf of the Laundry Owners' National Association resulted in the following conclusions: The results of these experiments indicate that an infusion-method for testing the bactericidal effect of any agent on an inoculated piece of cloth must not be considered to give more than a relative indication of the actual number of organisms present; that a count on the effluent from any washing bath does not give a true indication of the quantity of organism remaining in the clothes being washed; and that plating a portion of the cloth in question in agar gives a more positive indication. They also show that soap solutions at a temperature of 40° C. have a real bactericidal value. Considering the omnipresence of organisms that, under certain conditions, may be considered pathogenic, it appears absurd to demand that a clothes-washing process should render fabrics absolutely sterile; but it has been demonstrated that such results are actually obtained in the case of all garments that are finished by ironing or drying at high temperatures, and that, in the case of those not so treated, the washing with soap produces a bactericidal efficiency comparable to that obtained by pasteurization.

Manganese in water supplies: J. W. SALE. The water supply of Pierre, South Dakota, contains 2.3 to 3.0 milligrams per liter of manganese and 0.07 milligrams per liter of iron. Water mains in the vicinity of the well become clogged with a deposit of oxids of manganese in a short time. Solubility of the deposit in carbonated water is given. Laboratory experiments on removing the manganese are described and the general subject of manganese in water supplies is discussed.

RUBBER SECTION

L. E. Weber, *Chairman*

John B. Tuttle, *Secretary*

The Rubber Section of the American Chemical Society held its meeting on September 12, the program being as printed in the regular program of the society. About 90 members and guests were present. The meeting authorized the chairman and secretary of the section to appoint an executive committee, the purpose of this committee to be of assistance to the officers in the preparation of programs, meetings and such other matters as may arise. It was decided that a committee should be appointed, to investigate the subject of the poisoning effect of the organic accelerators used in the vulcanization of rubber, the report of this committee to cover a list of such substances, with a description of their effect on the workmen who come in contact with it, and the precautions which should be adopted in the mills to prevent fatal or even serious injury.

Effect of copper on crude rubber: CHAS. P. FOX. Reviews the work done along this line. Shows by exhibit of specimens results of experiments with copper acetate on crude rubber. Sustains the work of Dr. Morgan, director of the Rubber Planters' Association, Federated Malay States.

SCIENCE

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THE CARNEGIE INSTITUTION AND THE PUBLIC[1]

RECIPROCITY OF RELATIONS

IT is often openly asserted and more often tacitly assumed that an endowed altruistic organization acting under a state or a national charter may proceed without restrictions in the development of its work Thus, in accordance with this view, the institution is frequently congratulated on its supposed freedom from governmental control and on its supposed immunity from social restraint. But this view is neither consonant with fact nor consistent with sound public policy. All such organizations are properly subject not only to the literal constraints of their charters but also to the commonly more narrow though unwritten limitations imposed by contemporary opinion. The ideal to be sought by them in any case consists in a reciprocity of relations between the individual endowment on the one hand and the vastly larger and more influential public on the other hand. This ideal, however, like most ideals, is rarely fully attainable. Its existence and importance are, indeed, almost as rarely recognized. Hence, any new altruistic organization is apt to find itself oscillating between two extreme dangers: the one arising from action on the part of the organization prejudicial to public interests; the other arising from public expectations impossible of attainment and therefore prejudicial to the organization.

Happily for the institution, neither of these extreme dangers has been seriously encountered. Its evolution has proceeded without surpassing charter limitations and without permanent hindrance from an aggregate of expectations certainly quite unparalleled in the history of research establishments. But while thus far it has been practicable to steer clear of the rocks and the shoals toward which enthusiastic friends even of the institution would have it head, and to demonstrate the inappropriateness, the futility, or the impossibility of a large number of recurring suggestions for application of the institution's income, there remains a multitude of subjects and objects of omnipresent importunity for which the institution has furnished and apparently can furnish only general disappointment. Some references have been made occasionally in previous reports to these matters, but in general they have been ignored for the reason that they tend to waste energy in the production of nothing better than heat of controversy. A full enumeration and discussion of them would require nothing short of a volume, which would be of value probably only to our successors. There are two classes of them, however, presenting widely different aspects, which appear worthy of special mention in this connection and at the present unusual epoch in the intellectual development of mankind. These two classes find expression respectively in the perennial pleas of humanists for a larger share of the institution's income and in the more persistently perennial pleas of aberrant types of mind for special privileges not asked for, and not expected by, the normal devotees to learning.

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[1] Extract from the Report of the President of the Carnegie Institution, Washington, D. C., 1917.

CLAIMS OF HUMANISTS

Whenever and wherever the rules of arithmetic are ignored, then and there will develop vagaries, misunderstandings, and errors of fact that only the slow processes of time can correct. Hence it was not simply natural but necessary that in the evolution of the institution something like conflict surpassing the bounds of generous rivalry should arise between claimants whose aggregate of demands for application of income has constantly exceeded the endowment from which income is derived. Indeed, if the evidences of experience are to be trusted, there is scarcely a province in the world of abstract and in the world of applied knowledge which has regarded its needs as incommensurable with that entire income. It was an inevitable consequence, therefore, of inexorable conditions that a majority of the commendably enthusiastic workers in these numerous provinces should fail to get from the institution all the aid they desired. It was a similarly inevitable consequence of those conditions that some of these enthusiastic workers should attribute their disappointment to wrong causes. And it might likewise have been predicted with certainty that the largest share of the resulting disapprobation visited upon the institution should come from the province of the humanists, not because they possess any property of superiority, of inferiority, or any other singularity, but, firstly, for the reason that they are more numerous in the aggregate than the devotees of all other provinces combined; and, secondly, for the less obvious but more important reason that the subjects and objects of their province are more numerous, more varied, more complex, and in general less well defined than the subjects and objects of any other province.

Concerning all these matters humanistic which have agitated academic circles especially for centuries, the administrative office of the institution is naturally called upon to share in an extensive correspondence. Some of this is edifying, most of it is instructive, but a large if not the greater part of it appears to have been relatively fruitless in comparison with the time and the effort consumed. Why is this so? Or, is it only apparently and not actually so? May it not be due to the proverbially narrow, or possibly "materialistic," tendencies sometimes attributed to administrative officers? Much attention has been given to these inquiries with a view to securing answers free from personal bias and independent of administrative or other ephemeral restrictions Essentially correct answers are furnished, it is believed, by the voluminous correspondence referred to, since it has supplied the data required for application of the objective methods of observation and experiment as well as the data for application of the subjective methods of a priori reasoning and historico-critical congruity.

An appeal to that correspondence shows, in the first place, that there is no consensus of opinion amongst professed humanists as to what the humanities are. It is well known, of course, by those who have taken the trouble to reflect a little, that the words humanistic and humanist are highly technical terms, more so, for example, than the term "moment of inertia," the full mechanical and historical significance of which can only be understood by consulting Euler's "Theoria Motus Corporum Solidorum." Technically, the humanist is not necessarily humane, though fortunately for the rest of us he generally possesses this admirable quality; he needs only to be human. The distinction is well illustrated at one extreme by what Greg called the "false morality of lady novelists," which could doubtless be surpassed by the falser morality of male authors of fiction; and at another extreme by the merciful rôle of the physician in saving lives, or the equally merciful rôle of the engineer who builds bridges that will not fall down and kill folks, whose works, nevertheless, are often relegated by the humanist to the limbo of technology

But these finer shades of verbal distinction which, with more or less elaboration, have come down to plague us from the days of the illustrious Alcuin and Erasmus, but with no such intent on their part, are less disconcerting than other revelations supplied by this expert testimony. It shows, in the second place, the surprising fact that some few humanists would restrict this field of endeavor to literature alone. From this minimum minimorum of content the estimates of our esteemed correspondents vary with many fluctuations all the way up to a maximum maximorum which would embrace all that is included in the comprehensive definition of anthropology to be found in the Standard Dictionary. Thus some eminent authorities would exclude from the humanities all of the ancient classics even, except their literatures. To such devotees philology, literary or comparative, has no interest; while archeology, classical or cosmopolitan, is of no more concern to them than comparative anatomy, which latter, by the way, is held in certain quarters to comprise the whole of anthropology. Equally confident groups of enthusiasts, on the other hand, animated by visions held essential to prevent our race from perishing, would, each in its own way, have the institution set up boundaries to knowledge within which the humanities, as always hitherto, would play the dominant part but whose appropriateness of fixation would be immediately disputed by other groups. There would be, in fact, only one point of agreement between them, namely, that the institution's income is none too large to meet the needs of any group. It should be observed in passing, however, in fairness to our friends the humanists, that they are not alone in their regressive efforts to establish motes and bounds for advancing knowledge. Contemporary scientists have likewise pursued the same ignis fatuus with similarly futile results, as is best shown by the arbitrary and often thought-tight compartments into which science is divided by academies and royal societies. A sense of humor leads us to conclude that these likenesses between groups and assemblages thereof, still more or less hostile at times to one another, serve well to prove that the individuals concerned are human if not humanistic and that they all belong to the same genus if not to the same species.

In the third place, there is included in the extensive correspondence on which this section is mainly based a special contribution of letters furnished mostly by university presidents and professors and by men of letters selected with a view to excluding all those who might be suspected of any non-humanistic predilections. These letters were received as replies to a communication issued first during the year 1910, and occasionally since then, soliciting counsel from those well qualified to assist the institution in determining how it may best promote research and progress in the humanities and how it may be relieved of the charge of unfairness toward them in the allotment of its income. The essential paragraphs in this communication are the following:

> Amongst other suggestions arising naturally in this inquiry is that of the desirability of something like a working definition of the term humanities. To the question What are the humanities? one finds a variety of answers, some of which seem much narrower than desirable.
>
> In order to get additional information on this subject and in order to make this part of the inquiry as concrete and definite as possible, I am sending copies of the inclosed list of publications to a number of friends requesting them to mark those entries of the list which they, as individuals, would consider works falling properly in the fields of the humanities. I shall esteem it a great favor, therefore, if you will kindly examine this list, indicating by some sort of check-mark what works, if any, may be rightly so classed, and then mail the same in the inclosed stamped envelope. It will be of service also, to indicate to me, if you care to do so, the lines of distinction which may be drawn between the humanistic sciences and the physical sciences. I am sure you will agree with me that it will be a decided aid to all of us to secure something like common definitions for these boundaries of knowledge.

About thirty distinguished authors have participated in this symposium; and their frank and generous expressions of opinion would be well worthy of publication if they had not been assured that their responses would not be used for such a purpose. The identities and details of their letters must therefore be retained, for the present at any rate, in the archives of the institution. But since many of them have offered to relieve the solicitor of this obligation, and probably all of them would do so on request, it is believed that no confidence will be violated in stating the two following statistical facts, which not only agree with one another but strongly confirm also the inductions referred to above, drawn from the more miscellaneous correspondence of the institution:

1. The definitions of the term humanities vary from the exclusiveness of literature alone to the inclusiveness of the more recent definitions of anthropology, with a noteworthy tendency toward inclusiveness rather than the reverse.

2. To the concrete question What works, if any, already published by the institution fall in the humanities, the answers vary from 2 to 33, the number of publications up to 1910 being 146.

The correspondent who assigned the

largest number of publications to the humanities took the trouble also to count up the totals of the numbers of pages of all the works issued by the institution up to that time. His count gave: for the humanities, 10,813 pages; for all other branches of knowledge, 21,700 pages.

In connection with these statistical data, it is appropriate to add the corresponding figures for the publications of the institution brought down to date, namely, October, 1917. In deriving these there are included under the humanities works in archaeology, folk-lore, international law, history, literature, and philology. Of a total of 88 volumes, 58 octavos contain 19,921 pages and 30 quartos contain 10,718 pages, the total number of pages being 30,639; but four of the volumes are still in press and their pagination is not included.

Since the total number of pages of printed matter issued by the institution up to date is 98,565, it appears that the shares, if such a term may be used, allotted to the humanities and to all other fields of learning combined are in round numbers one third and two thirds respectively. Whether this is one of fairness and fitness will doubtless remain for a long time a disputed question, since it seems to be one to which the dictum of Marcus Aurelius applies with peculiar emphasis. In the meantime, while waiting for a diminution in the diversity of opinion which calls that dictum to mind, it appears to be the duty of the institution to proceed, as it has sought to proceed hitherto, in a spirit of sympathy and equity based on merit towards all domains of knowledge, with a full appreciation of the necessary limitations of any single organization and with a respectful but untrammeled regard for the views, the sentiments, and the suffrages of our contemporaries.

ABERRANT TYPES OF MIND

If words and phrases drawn out of the past may obscure thought and supplant reason in the domains of the less highly developed sciences, like the humanities, for example, they are by no means free from difficulties when used as media for the communication of ideas in the domains of the more highly developed sciences. The differences between the ambiguities and the obscurities of the two domains are mainly in degree rather than in kind. It is a truism, of course, that in general it is much easier to discover errors and to improve uncertain verbal expression in the definite than in the indefinite sciences. Erroneous statements and interpretations of fact may be often corrected by the facts themselves or by means of a knowledge of their relations to underlying principles. Precision and correctness of language are also greatly increased in any department of learning when it becomes susceptible to the economy of thought and of expression characteristic of the mathematico-physical sciences. The perfection of these latter is, indeed, so great that novices working in them are often carried safely over hazardous ground to sound conclusions without adequate apprehension of the principles involved and with only erroneous verbal terms at command to designate the facts and the phenomena considered.

Nevertheless, it must be admitted that the terminology of what commonly passes for science as well as the terminology used frequently even by eminent men of science is sadly in need of reformation in the interests of clear thinking and hence of unequivocal popular and technical exposition. To realize the vagueness and the inappropriateness in much of the current use of this terminology one needs only to examine the voluminous literature available in almost any subject called scientific.

It is so much easier to appear to write well, or even brilliantly, than it is to think clearly, that facile expression is often mistaken for sound thought. Thus, to illustrate, while in physics the terms force, power and energy have acquired technical meanings entirely distinct and free from ambiguity, they are commonly used as synonyms, and quite too commonly to designate properties, sentiments, and influences to which their application is meaningless. The "forces," the "powers," and more recently, the "energies" of "nature" are frequently appealed to in popular literature; and a familiar bathos consists in equipping them solemnly with the now vanishing stable furniture "for the benefit of mankind." Science is disfigured and hindered also by much inherited antithetical terminology for which reasons once existent have now disappeared or are disappearing. Instances are found in such terms as metaphysics, natural history, and natural science, the two latter of which appear to have come down to us without sensible modification, except for a vast increase in content, since the days of Pliny the Elder. The diversification and the resulting multiplication of meanings of the terms of science are everywhere becoming increasingly noticeable and confusing. One of the most recent manifestations is seen in the phrase "scientific and industrial research," which probably means about the same thing as the equally uncertain phrase "pure and applied science"; while both phrases have been turned to account in setting up invidious distinctions inimical to the progress of all concerned.

This looseness in the use of terminology inherited from our predominantly literary predecessors and the prevailing absence of any exacting standards of excellence in exposition make it easy for that large class here designated as aberrant types to take an unduly prominent part in the evolution of any establishment founded for the promotion of "research and discovery and the application of knowledge for the improvement of mankind." These types are numerous and each of them presents all gradations ranging from harmless mental incapacity up to aggressive pseudo-science, which latter often wins popular approval and thus eclipses the demonstrations of saner counsels. The representatives of these types are variously distinguished in common parlance as cranks, quacks, aliens, charlatans, mountebanks, etc. Some of the most persistent types are known as arc-trisectors, circle-squarers and perpetual-motion men and women. They are not of recent development; they are coextensive with our race; but they have been little studied except in the cases of extreme divergency from the normal. One important work, however, has been devoted to the intermediate types of this class with which the present section of this report is concerned. This is the profoundly learned book entitled "A Budget of Paradoxes,"[3] by Augustus De Morgan, who gave a surprising amount of attention, extending through several decades, to these people, whom he called "paradoxers."

It ought to be well known, but evidently is not, that the institution has had to deal with, and must continue to be harassed by, great numbers of these aberrant types. The happy phrase of the founder concerning the "exceptional man" has worked out very unhappily both for them and for the institution, since it has only inevitable disappointment to meet their importunate demands, while they in turn have only inevitable animadversion to visit finally upon the institution. Deluded enthusiasts and designing charlatans entertain alike the illusion that here at last is an establishment that will enable them to realize their wildest dreams of fame and fortune. But in the end the hopes of these people are either rudely shocked or wrecked, not because the institution would disturb them in their fancies but because they compel the institution to decline to approve their theories and to subsidize their projects. Many individuals of this class are extraordinarily clever, in literary capacity especially, although they are almost all notably deficient in critical faculties. In the initial stages of correspondence with them they are wont to attribute superhuman qualities to the administrative officer concerned, but if he becomes at all exacting they are wont to suggest a speedy degeneracy for him towards inhuman qualities. The absurdities, the arrogance and the audacity (often pushed to the extreme of mendacity) of their claims are generally ludicrous enough, but these claims are often founded also on recondite fallacies which present pathetic as well as humorous aspects. Two illustrations drawn from the older and hence more impersonal sciences may suffice to indicate the nature of the daily experience here in question:

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[3] This was published originally in 1872. A second edition in two volumes, edited by Professor David Eugene Smith, has recently (1915) been issued by the Open Court Publishing Company, of Chicago and London.

1. A teacher of youth in a public school desires assistance in securing letters-patent for a new proof of the Pythagorean theorem. And why not, since we read every day in the public press and in the debates of legislative bodies of "principles" being patented?

2. Quite recently it has been "discovered" that the air and the ether contain "free energy." If this is so, if energy like urbanity is free, why should it not be rendered available at the expense of the institution for the improvement of mankind?

Study and reflection concerning these aberrant types and an intimate association with them beginning thirty years before the foundation of the institution, all point to the conclusion that responsibility for their undue prominence must be attributed in large degree and in the last analysis to a prevalent inadequate development of critical capacity even amongst the best educated classes of contemporary life. Many representatives of these latter regard the eccentric individual as thereby worthy of special attention. He is often referred to as a sprite or as a male witch, but commonly, of course, under the more familiar designations of our day as "a genius" or as "a wizard." Thus it is quite easy for obvious charlatans and ignoramuses, as well as for those in pursuit of Sisyphean paralogisms and anachronisms, to secure letters of introduction and commendation to the institution from distinguished people, who pass the applicants along on the theory apparently that no harm can result from an effort to assist in the laudable work of extending learning. It is assumed that a research establishment must have effective facilities for utilizing the necromantic capacities attributed to those in particular to whom the terms genius and wizard are by common assent applied. Such introductions and commendations are generally held to be equivalent to approvals which may not be lightly set aside. The suggestion of tests of the pretensions and of checks on the deductions of these applicants is repulsive to them. What they desire is not diagnosis but indorsement. In all these matters there is revealed likewise a widely diffused misapprehension concerning the meanings of the terms science and research. The first may mean anything from occultism to the steam engine or to the telephone and thence up to those rarely appreciated principles of which the law of conservation of energy is one of the most conspicuous examples. The other term has a similarly wide range of meaning, but it stands most commonly either for a secret process which leads to riches by way of patent offices or for enterprises in which the institution is supposed to act as a complaisant disbursing agency.

In dealing with these aberrant types there are encountered certain other fallacies of a more specious and hence of a more troublesome character. They arise out of the prevailing innocence of, if not contempt for, the doctrine of probabilities. The simplest of these fallacies is seen in the common belief that one mind is as likely as another to make discoveries and advances in the realms of the unknown. Thus it is assumed that research establishments should maintain experts, or corps of them, for the purpose of promoting the efforts of tyros, amateurs and dilettanti, or, in other words, perform the functions of elementary schools. A subtler fallacy is expressed in the more common belief that a research organization should occupy itself chiefly in soliciting and in examining miscellaneous suggestions. It is held that if these are received in large numbers and if they are read long enough and hard enough, the possibilities of knowledge will be completely compassed. This has been elsewhere called the process of "casting dragnets in the wide world of thought . . . with the expectation that out of the vast slimy miscellanies thus collected there will be found some precious sediments of truth." It is, indeed, a metaphysical method of extracting truth out of error. The worst of all these fallacies is found in the not unpopular notion that if experts could be set at work under the direction of inexperts great progress could be achieved. This is the fallacy so often used to justify placing technical work under the administration of politicians and promoters rather than under the charge of competent men. It finds frequent expression also in suggestions to the institution that its corps of investigators might avoid the dangers of "respectable mediocrity" by yielding to the requests of the less conservative and more brilliant advocates of advancing knowledge.

But what, it may be asked, are the characteristics which differentiate these pseudo-scientists from normal investigators? They are well defined and not numerous. The pseudo-scientist is in general excessively egoistic, secretive, averse to criticism, and almost always unaware of the works of his predecessors and contemporaries in the same field. He displays little of that caution which is born of adequate knowledge. He is lacking especially in capacity to discover and to correct his own mistakes. He is forever challenging others to find errors in his work. He has an overweening confidence often in formal logic, but is unable to see that this useful device may play tricks by bringing him, for example, simultaneously to right and to wrong conclusions by reason of wrong premises. His worst defect is manifested in asking for and in expecting to get more lenient consideration in the forum of demonstration than that accorded to his more modest but more effective competitors.

How inadequate are the hasty popular estimates of these exceptional individuals is sufficiently witnessed in the extensive experience of the institution. In the brief interval of its existence it has had to deal with about 12,000 of them. Many of these have been commended to the institution in terms well calculated to set aside the laws of biologic continuity and thus to elevate the aspirants abruptly from irreproachable respectability to questionable fame. To some of them have been attributed qualities worthy of the mythological characteristics conceived by the unrestrained imaginations of men in prescientific times. Not a few of them have proved to be obvious fakers, schemers or incompetents masquerading in the name of learning with the confident expectation that the institution would indorse, finance or otherwise promote their objects under the guise of research. But, as might have been predicted, the history of all this varied experience is a history of futility clouded here and there by manifestations of the baser traits of mankind and lighted up only occasionally by flashes of wit, wisdom or humor in the prevailing pathologic cast.

Robert S. Woodward

SCIENTIFIC EVENTS

CONJOINT BOARD OF SCIENTIFIC STUDIES IN GREAT BRITAIN

The first annual report of the Conjoint Board of Scientific Studies, established at the instance of the Council of the Royal Society in June, 1916, has been issued. As reported in the *British Medical Journal,* the objects of the board are to promote the cooperation of those interested in pure or applied science; to supply means by which the scientific opinion of the country on matters relating to science, industry and education, may find effective expression; to promote the application of science to industries and the service of the nation; and to discuss scientific questions in which international cooperation seems advisable. The chairman of the board, which consists of representatives of numerous societies, is the president of the Royal Society. Among the constituent societies are the Royal Anthropological Institute, the Royal Colleges of Physicians and Surgeons in England, the Royal Society of Medicine, the Pharmaceutical Society of Great Britain, the Psychological, Linnean, Zoological, Biochemical, and Psychological Societies, the Institute of Chemistry, the Society of Chemical Industry, the Chemical Society, and the Royal Institute of British Architects. There is a small executive committee, of which Sir Joseph J. Thomson, president of the Royal Society, is chairman, and Dr. W. W. Watts, professor of geology in the Imperial College of Science and Technology, secretary; among the other members are Sir Alfred Keogh and Sir Ray Lankester. The board has appointed a number of sub-committees, some of which appear to have got to work during the year, including The International Catalogue Subcommittee which has obtained information regarding the extent of the use made by scientific men of the present International Catalogue of Scientific Literature; the Watching Subcommittee on Education, of which Sir Ray Lankester is convener, the Metric System Subcommittee, and the Anthropological Survey Subcommittee. The last named consists of Major Leonard Darwin (convener), Professor A. Keith (secretary), Dr. James Galloway, Dr. P. Chalmers Mitchell, and Professors G. Elliot Smith, Karl Pearson and Arthur Thomson. It has presented a report on the need of a physical survey of the British people, and intends to institute further inquiries before drafting recommendations. On its advice the executive committee asked the Board of Education, the Local Government Board, and the Registrar-General's Office to nominate representatives on the subcommittee, and Sir George Newman, Sir Arthur Newsholme, and Dr. T. H. C. Stevenson, have been appointed. The Watching Subcommittee on Education has held a conference with the Council of Humanistic Studies, and has made a report to the Conjoint Board, in the course of which it recommended that both natural science and literary subjects should be taught to all pupils below the age of 16, and that afterwards specialization should be gradual and not complete. It points out that in many schools of the older type more time, which can often be obtained by economy in the time allotted to classics, is needed for instruction in natural science, but that in many schools more time is needed for instruction in languages, history and geography. The opinion is also expressed that while it is impossible and undesirable to provide instruction in both Latin and Greek in all secondary schools, provision should be made in every area for teaching these subjects. The subcommittee also transmitted to the Government Committee on Science in the Educational System of Great Britain two recommendations on which it was unanimous; one is that in order to secure teachers able to give inspiring and attractive courses in science adequate salaries should be paid, and the other, that while prime importance must be attached to provision for laboratory work it was essential that there should be instruction also in the romance of scientific discovery and its applications. Every pupil should not only receive training in observational and experimental science, but should be given a view of natural science as a whole, the object being to evoke interest in science in relation to ordinary life, "rather than to impart facts or data of science presented by an examination syllabus, or even to systematize their rediscovery."

WIRELESS TIME SERVICE IN THE PHILIPPINE ISLANDS

The progress in the time service of the Philippine Islands is made evident from the fact that since October 1, 1917, the Cavite Radio Station, cooperating with the Bureau of Posts and the Manila Observatory, sends out time signals of the 120th meridian East of Greenwich at 11 A.M. and 10 P.M. every day, Sundays and holidays inclusive. Manila holds an enviable position in the Pacific and the interests of shipping companies making Manila a port of call are too prosperous to be overlooked. Accurate time signals and wise typhoon warnings are of immense value to the units of the United States Asiatic Fleet, to Army transports and in general to oversea shipping.

For the purpose of sending time signals, the transmitting clock of the Manila Observatory is connected with the Cavite wireless station through the Bureau of Posts. Manila Observatory time signals begin at 10:55 A.M. and 9:55 P.M., standard time of the 120th meridian East of Greenwich; and continue for five minutes. During this interval every tick of the clock is transmitted, except the 28th, 29th, 54th, 55th, 56th, 57th, 58th and 59th of each minute. Experiments made on board the *U. S. Wilmington, Monterey, Sheridan, Merrit* and the commercial steamer *Colombia,* of the Pacific Mail, gave satisfactory results.

PROFESSOR W. A. NOYES AND THE AMERICAN CHEMICAL SOCIETY

Resolutions on the services of Professor W. A. Noyes to the American Chemical Society have been passed, as follows:

Whereas, Dr. William A. Noyes is soon to terminate his service as editor of the *Journal of the American Chemical Society,* to which for fifteen years he has, with unceasing devotion and conscientious care, given a large portion of his time; and

Whereas, During these years he has by his effective conduct of the *Journal* raised it to a scientific publication of the very first rank, in which is now published by far the greater part of the best chemical research carried on in this country, and

Whereas, He was the leading spirit in the organization and detailed planning of the *Abstract Journal* of the Society, which has made available to American chemists in an exceptionally comprehensive and satisfactory form the current chemical research of the world; and

Whereas, He has thus contributed in a vital way to the phenomenal increase in membership and scientific activity of the Society during the last two decades, in which the success of its journals has been one of the most important factors; now, therefore, be it

Resolved, That the Council of the Society expresses its keen regret that other tasks have compelled the resignation of Dr. Noyes from the editorship of the *Journal,* and records its high appreciation of his services to the Society, especially of his ardor in developing the Society's journals, which will remain a splendid monument to the success of his work.

(For the Council) Signed by

Wilder D. Bancroft,
Marston T. Bogert,
John H. Long,
Arthur A. Noyes,
Theodore W. Richards, *Chairman*

THE ANNUAL MEETINGS OF THE BIOLOGICAL SOCIETIES

THE annual scientific meetings of the Biological Societies (The Federation of American Societies for Experimental Biology, The American Association of Anatomists and The American Society of Zoologists) will be held in the University of Minnesota, Minneapolis, Minnesota, December 27, 28 and 29.

The Hotel Radisson will be headquarters for all the societies. Arrangements will also be made with fraternity and boarding houses for those desiring them.

The federation has arranged to hold a day session at the Mayo Clinic in Rochester, Minnesota, on December 29. For this purpose arrangements have been made to have sleeping cars leave Minneapolis on the night of the 28th in order that no time shall be lost. The Mayo surgical hospitals will be visited, as will also the experimental laboratories and at the afternoon session a scientific program will be presented. Members of the federation should have their tickets from the east routed from Chicago to Minneapolis and from the west through Omaha or Kansas City to Minneapolis. Tickets for the return trip should be routed from Minneapolis over the Chicago and Great Western Railway to Rochester and from Rochester to Chicago for the east, and to Omaha or Kansas City for the west. Members of the Anatomical and Zoological Societies are cordially invited to attend this Rochester meeting if they care to do so, although programs for these societies have been arranged for the same date in Minneapolis.

There will be a joint dinner in the Gold Room, Hotel Radisson, on Thursday at 6:30 P.M. at $1.50 per plate, also, a joint smoker will be held at the Teco Inn, Hotel Radisson, at 8:15 P.M. on Friday. Fifty-cent luncheons will be served at 1 P.M. in the Minnesota Union, University of Minnesota, each day throughout the meetings.

After full consideration by the executive committees and councils of the societies concerned, it has been decided to hold the meetings in Minneapolis on December 27, 28 and 29, as voted one year ago. This action is taken on the ground that *it would be disastrous to the progress of research and the best interests of the biological sciences if no annual meetings for the reporting of investigations, for the exchange of ideas and for mutual encouragement should be held.*

The local committee at Minneapolis cordially endorses this decision on the part of the authorities of the several societies and desires to emphasize in addition the impetus that can be given to science in the northwest by a successful meeting at the University of Minnesota. To this end they are planning for a program of unusual interest. Not only will scientific papers of value be presented before the various societies—papers which in many instances will deal with matters pertaining to the war—but also visitors will have an opportunity to see the recent new laboratories of the University of Minnesota and especially to visit under the best of conditions the Mayo Clinic at Rochester and become acquainted with the research work going on there under the Mayo Foundation.

On behalf, therefore, of the University of Minnesota and with the cordial concurrence of its president and board of regents we invite you to attend these meetings. We urge you as a duty to science to help make the gathering a success. We believe that it is incumbent upon every scientific man to support the cause to which he has devoted his life, the cause of scientific progress. We, therefore, most respectfully and earnestly urge you to attend these meetings, to contribute to the programs, to take part in the discussions and to bring to the support of science the same loyalty and sacrifice that America is giving to every other basic principle of our civilization.

We also ask that you inform young scientists of your staff and acquaintance who are not yet members of the societies, concerning these meetings, and invite them to be present.

L. G. ROWNTREE,
Chairman, Local Committee

SECTION M (AGRICULTURE) OF THE AMERICAN ASSOCIATION AT PITTSBURGH

THE Section of Agriculture will hold sessions on Friday and Saturday, December 28 and 29. A symposium on the topic "Factors concerned in an increased agricultural production" will be held on Friday afternoon, December 28, at 2 o'clock, the subject to be considered under the following five heads:

Present status of production, Dr. John Lee Coulter, dean of agriculture, West Virginia University.

Feasibility of increasing production, Dean E. Davenport, college of agriculture, University of Illinois.

Obstacles to enlarged production, Professor W. D. Hurd, assistant to the Secretary of Agriculture.

Limiting factors in production, Professor Chas. E. Thorne, director of the Ohio Experiment Station.

The human element, Mr. Herbert Quick, member of the Federal Farm Loan Board.

The address of the retiring vice-president of the section, Dr. W. H. Jordan, director of the New York State Experiment Station, upon "The future of agricultural education and research in the United States," will be given on Saturday morning, December 29, at 11 o'clock. The sessions will be presided over by Dr. H. J. Waters, president of the Kansas State Agricultural College. They will be held in Room 105, Thaw Hall, University of Pittsburgh.

The symposium deals with a subject of the first importance to agriculture and to the welfare of the nation. It will be treated in a semi-popular manner, having in mind the broad general interest relating to it.

SCIENTIFIC NOTES AND NEWS

The Royal Society has conferred Royal medals on Dr. John Aitken, for his researches on cloudy condensations, and on Dr. Arthur Smith Woodward, for his researches in vertebrate paleonteology, and the Copley medal on M. Emile Roux, for his services to bacteriology and as a pioneer in serum therapy; the Davy medal on M. Albin Haller, for his researches in organic chemistry; the Buchanan medal on Sir Almroth Wright, for his contributions to preventive medicine; and the Hughes medal on Professor C. G. Barkla, for his work on X-ray radiation.

Dr. Christopher Addison, minister of reconstruction in Great Britain, has been appointed minister of public health, and hopes to carry a bill through parliament before Christmas, forming a new ministry to forward a place for the nationalization of the medical profession with free medical attendance for every one.

Major Benedict Crowell, of Cleveland, an engineer officer, now in charge of the Washington office of the Panama Canal, has been appointed assistant secretary of war to succeed William Ingraham, who has become surveyor of the Port of Portland.

Dean Klein, of the veterinary department of the University of Pennsylvania, is at present in France, having been sent by the government on a special mission to General Pershing to consult him regarding the organization of the Veterinary Corps, and to make a survey of the situation in France.

Dr. R. B. Owens, secretary of the Franklin Institute, now in France on leave of absence, acting as head of the Army Intelligence Bureau, has been elevated to the rank of major. He is serving under General Pershing.

Mr. George E. Holm, research assistant in the division of agricultural biochemistry of the University of Minnesota, has been commissioned first lieutenant in the Sanitary Corps. He will be assigned to investigational work in the Gas Defense Service.

Dr. Charles L. Reese, chemical director of the du Pont Powder Company, has been elected a member of the board of directors of that company.

Mr. F. G. Moses has been appointed hydrometallurgist in the U. S. Bureau of Mines, with headquarters at Salt Lake City station.

J. W. Turrentine is directing the work of the government's experimental kelp-potash plant at Summerland, near Santa Barbara, Cal. The plant is in operation and is producing crude potash. Apparatus is now being installed which will make possible the production of refined potash and by-products, particularly iodine, for both of which chemicals there is a large demand for industrial and military purposes.

PROFESSOR H. E. GREGORY, of Yale University, has left for the Hawaiian Islands, where he plans to spend a few months in geological investigation.

PROFESSOR C. C. NUTTING, who will lead a party of Iowa scientific men in an expedition to the West Indies next summer, has received word that the English government buildings on the Pelican islands, which will be the base of the expedition, will be turned over to the explorers without cost. Some of the men who intended to go with this expedition at first have since entered war service, but plans are going forward rapidly and the outlook is promising. Professor Nutting made a preliminary visit to the islands last summer and reported that he had never seen a place where the opportunity for scientific research was greater.

PRESIDENT STIEGLITZ, of the American Chemical Society, has appointed the following committee on the supply of organic chemicals for research during the war: E. Emmet Reid, *Chairman,* Roger Adams, H. L. Fisher, J. W. E. Glattfeld, Wm. J. Hale.

AT the annual meeting of the Cambridge Philosophical Society held on October 29 the following were elected officers of the society for the ensuing session: *President,* Professor Marr; *Vice-presidents,* Professor Newall, Dr. Doncaster and Mr. W. H. Mills; *Treasurer,* Professor Hobson; *Secretaries,* Mr. A. Wood, Mr. G. H. Hardy and Mr. H. H. Brindley; *New Members of Council,* Sir J. Larmor, Professor Eddington and Dr. Marshall.

AT the anniversary meeting of the Mineralogical Society, held on November 6, the following were elected officers: *President,* Mr. W. Barlow; *Vice-presidents,* Professor H. L. Bowman and Mr. A. Hutchinson; *Treasurer,* Sir William P. Beale, Bart.; *General Secretary,* Dr. G. T. Prior; *Foreign Secretary,* Professor W. W. Watts; *Editor of the Journal,* Mr. L. J. Spencer.

AT Yale University, Director Russell H. Chittenden and Professor Irving Fisher have delivered the first two of the special University Lectures on Food Conservation, and Frederic O. Walcott, '91, of Mr. Hoover's staff, will give the third lecture, on "Governmental aspects of food conservation," in January.

ALONZO DORUS MELVIN, chief of the Bureau of Animal Industry, since 1905, known for his work on animal diseases and their bearing on human health, died at his home in Washington, aged fifty-five years.

UNIVERSITY AND EDUCATIONAL NEWS

THE Harvard University Corporation has announced the receipt of securities to the value of $89,946.50 from James Byrne, '77, of New York City, to establish the "Byrne professorship of administrative law." The securities are the first payment towards a total foundation of $150,000.

THE following telegram was sent by Dr. Hollis Godfrey, December 5, to presidents of all institutions giving degrees in technical courses: "I have just been authorized by the Secretary of War to request you to inform all your technical students that if they wait until drafted they can, upon summons to the draft camp, take with them a letter from you stating their special qualifications, such letter to be filed with occupational census questionnaire of the War Department. Under authority of this authorized telegram, the Secretary of War also authorizes me to say that every effort will be made to use each student's special training in connection with specialized occupations in the army, so as to afford technical students of draft age fully as great an opportunity through the draft as if they enlisted now."

THE annual meeting of the American Mathematical Society will be held in New York City on Thursday and Friday, December 27–28. The fortieth regular meeting of the Chicago Section will be held at the University of Chicago on Friday and Saturday, December 28–29. Friday afternoon will be devoted to a joint meeting with the Mathematical Association of America, at which Professor W. B. Ford will deliver his retiring address as chairman of the section.

Mr. L. O. Howard, consulting engineer of Salt Lake City, has been appointed dean of the School of Mines of the State College of Washington at Pullman.

At the Stevens Institute of Technology, L. A. Hazeltine has succeeded the late Professor Ganz as acting professor of electrical engineering in charge of the department.

James H. Ellis, research associate in physical chemistry at Throop College of Technology, Pasadena, Cal., has become a member of the physics department of the college as instructor in electrical measurements.

Mr. I. L. Miller, of Indiana University, has been appointed professor of mathematics in Carthage College.

Professor A. S. Leyton has resigned the chair of pathology and bacteriology of the University of Leeds.

DISCUSSION AND CORRESPONDENCE

SOCIEDAD CIENTÍFICA ANTONIO ALZATE

For those who have been led by a perusal of the daily papers to suppose that Mexico was in a progressive state of disorganization, the recent issues of the "Memorias" of the "Sociedad Científica Antonio Alzate," of Mexico City, will afford good proof that their hasty judgment had been erroneous.

The thirty-sixth volume of the Memorias of this Society, which has just appeared, and comprises 740 pages of text with 82 plates, is entirely devoted to a monograph on the State of Puebla by Señor Enrique Juan Palacios.[1] His study falls into three main sections, the first of which regards the ethnology, geology and climatology of the state, the second, its flora and fauna, its industries, its mineral resources, and its commerce and means of communication; the third section treats of the political divisions of the state, and of its history, embracing a description of its principal communities, chief among which is of course the city of Puebla, consisting of about 100,000 inhabitants.

The area of the state is given by the writer as 33,653 square kilometers, or about 14,000 square miles, and its population as nearly 1,100,000, showing a density of nearly 80 to the square mile. In population it ranks third among the Mexican states. The white race numbers 86,000, the population of mixed race 826,000 (three quarters of the whole), and the Indians, nearly 200,000. Within its territory is the highest peak in North America, with the exception of Mount McKinley. This is the mountain bearing the Indian name Citlaltépel, or "Smoking Mountain," though often called Orizaba. It rises to a height of 5,675 meters, or 18,614 feet, and is an extinct, or at least an inactive volcano.

The fossil remains found in the state of Puebla are of considerable importance. Among them are bones of *Elephas Columbi* Falconer, found at San Jeronimo, in the district of Tehuacán, and also in the region about the city of Puebla. Within the limits of its municipality, at Molino de Santa Barbara, fossil elephant tusks have been unearthed; mastodon tusks have also been discovered in the state, as well as teeth of *Elephas primigenius* (pp. 54, 55).

Ample space has been devoted to the mineral resources of Puebla and to their exploitation. While the principal interests of the state are agricultural and industrial, there were, according to the statistical report of 1907, as many as 29 mines then in operation (copper, iron, gold, silver and lead), the number of persons employed being 1,068; the production was valued at 1,168,428 Mexican dollars. Most of these mines must have been small undertakings, since Southworth in his Mining Directory for 1908 only notes three mines as in active operation, that of San Lucas (gold and silver) in the district of Tehuacan; that of Tetala, an English company organized in 1904, with a capital of £100,000, and the mine "La Aurora" of Tezuitlan, an enterprise dating from 1905, and having resources put at 10,000,000 Mexican dollars.

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[1] "Memorias y Rivista de la Sociedad Científica Antonio Alzate," published under the direction of the perpetual secretary, Rafael Aguilar y Santillan, Tomo 36, 2 parts, Mexico, June, 1917. 740 pp., 82 plts., 8°, "Puebla, su territorio y sus habitantes," by Enrique Juan Palacios.

Of what might be called precious-stone material there is very little signalized; some opal is found at Tecali and Tlatlauqui, and azurite occurs in Acatlan. The so-called "Mexican Onyx" (an aragonite) of the district of Tecali in the state of Puebla is well known, and was already used by the Aztecs for ornamental purposes.

In the State College in Puebla, where courses of law, medicine and engineering are given, besides the customary preparatory studies, there are excellent collections illustrating physics, chemistry, bacteriology and histology, and also radiographic and radioscopic installations, as well as apparatus for wireless telegraphy. There is also a well-furnished natural history collection and an important museum.

The few items presented here may give a little idea of the quality of this monograph, though insufficient to indicate the wide field it so ably covers. It certainly merits to be consulted by all who are seeking information regarding one of the principal states of the Mexican Federation. GEORGE F. KUNZ

NEW YORK CITY

THE TALKING MACHINE AND THE PHONOGRAPH

TO THE EDITOR OF SCIENCE: Professor Peckham's interesting account of the talking machine, as distinguished from the phonograph, in SCIENCE of November 9, closes with this statement:

> It is not probable that any one had thought of a phonograph in the sense in which we use the term as early as 1772. Knowledge of electricity was not sufficiently advanced at that time.

This, I presume, is a mere slip of the pen, the writer thinking perhaps of the telephone while writing of the talking machine and the phonograph. Otherwise some of us who are engaged in other fields of science, and hence can lay claim to no special knowledge of physics, would like to have pointed out to us the connection between electricity and the ubiquitous phonograph.

J. VOLNEY LEWIS

SCIENTIFIC BOOKS

Mental Adjustments. By FREDERICK LYMAN WELLS, Ph.D. New York & London: D. Appleton & Co., 1917.

F. L. Wells wrote his book with a rather unusual background. Trained in the experimental school of Cattell and Woodworth, Wells took up his work at the McLean Hospital in 1907, where he returned after one year's work with Dr. August Hoch on Ward's Island and with considerable contact with Dr. Charles Macfie Campbell, to whom the book is dedicated. Coming from a school which might be frankly dynamic and objective, if it had the necessary philosophical courage combined with a desire for consistency, Wells found most valuable opportunities at the McLean Hospital owing to the excellent tradition established there by Dr. Hoch in the study of an uncommonly interesting type of patients; and even before he went to Ward's Island he had been concerned with association experiments and with problems which were bound to bring him into touch with the sphere of ideas of Freud and Jung. His studies of the last few years have shown a growing mastery of the psychopathological problems and the present book gives ample evidence of earnest and able collaboration along lines very characteristic of modern American psychopathology.

Eight chapters constitute this book of 331 pages. In "Mental Adaptation" he gives illustrations of types and problems of adaptation and in a way a forecast of the book. The discussion of "Use and waste in thought and conduct" leads the reader, in one of the best organized chapters of the book, to a very direct understanding of fundamental adaptive trends and their adjustments and supplements, many times crossing the boundary between the "motor" and "mental" varieties of behavior, "granting, indeed, that such a boundary exists." He gives a very good picture of the rôle of fancy and autistic thinking (i. e., primitive fancy unconcerned about reality) and especially of the rôle of word-plays and of rationalization. He sums up the discussion by saying that "realistic thinking contributes mainly to making it possible to exist, and autistic thinking to making it worth while to live."

Pages 71 to 113 are devoted to Symbolic Association, in a chapter showing a remarkably wide range of resources of reading, and leading from the symbolisms of language and of normal waking life to those of dreams.

The discussion of emotion is given the title "The continuity of emotion," and deals with "affective displacement" (a somewhat questionable term for affective diffusion and disproportions) and affective compensation. The more specific types of "affective displacement" are exemplified by a number of "unaccountable" dislikes and in the use of contrast and exaggeration in humor. "Loaded" experiences and transference are reduced to the principle that emotions are to be viewed as reactions, which are switched in and out according to the principle of associated reflex and conditioned and associated responses. The switching off of the affect is spoken of as a de-emotionalizing and siphoning process. The rôle of various complexes and affective symbolism is illustrated by many examples. The phrase "Objekt vergeht, Affect besteht" expresses the meaning of the title of the chapter.

The discussion of "Types of Dissociation" is more clearly systematic than most of the rest of the book and is a valuable survey for the student, although perhaps somewhat heavily loaded with varieties and subvarieties for those readers who have but little concrete experience, and who might have a desire for principles rather than for details. Chapter VI. (pp. 204–226) takes up the dynamic importance of factors which determine repressions and its various degrees. Chapter VII. takes us into the field of available experimental approaches, with a discussion of various types of intelligence tests, the association method, and those involving what is called measurements by relative position (the "better or worse"), free association, the schedule of personality study; and a final chapter dealing with "Balancing Factors" gives a valuation of various trends for life and the quest of happiness and application to education.

It is, I suppose, both a merit and a drawback of the book that it resists a brief summarizing survey. Clearness of principles and the ease of reading might readily gain by moderation in the amount of illustration and in the use of metaphors, or, since most of these are really well chosen, by paragraphs of orientation. The few paragraphs of this character certainly do much to make one more receptive.

Wells puts forth as his aim not to tell us things, but to enable us to see for ourselves what we would otherwise miss. He does, in fact, tell us so many things that one feels very much the importance of what he himself calls "strategic regrouping," of the author's treasure of reading and of observation. Every reader of the replete volume must be willing to do his share; those who do so will certainly find a rich material and ample work. How readily the book would lead one not already experienced in the field will have to be tried out. The reviewer can not help feeling that medical responsibilities with the cases and the material might have added a kind of practical simplicity and directness where the reader might be apt to lose himself in the detail. Wells does, however, make it clear that the normal and the abnormal are made of much the same material, and his book, with its softened rendering of Freudian conceptions, will be a stimulus and a help along sane and useful lines.

ADOLF MEYER

The Combination of Observations. By DAVID BRUNT, M.A. (Cantab.), B.Sc. (Wales), Lecturer in Mathematics at the Monmouthshire Training College, Cærleon, Mon. Cambridge University Press. 1917. Pp. x + 219.

This book gives an elementary treatment of the methods of adjusting observations. The normal or Gaussian law of error is derived from Hagan's hypotheses regarding the nature of errors, and the presentation in this connection is very attractive. The book gives a brief and simple treatment of certain important parts of the theory of statistics. This includes Pearson's generalized frequency curves first published in the *Philosophical Transactions* of the Royal Society, 186 A, p. 343. These curves include six types besides the normal curve, but the book makes no reference to the five additional types of curves recently published by Pearson.[1] The book presents a treatment of the correlation of two systems of variates. The treatment is, in general, clear, and should serve a useful purpose in making better known to persons who are applying these methods to data the nature of some of the limitations that underlie the interpretations of correlation coefficients. However, the reviewer has one criticism to offer. On p. 155, using r for the correlation coefficient, we are told that "it seems doubtful whether any serious meaning can be attached to values of r which are less than .5." It seems to the reviewer that this statement should be modified. To be sure, the statement would hold if the correlation coefficient r were calculated from such a small number of observations that the probable error of r is not particularly small compared to r. But when the conditions under which the formula for probable error of r is derived are well satisfied, r may be much smaller than 0.5 and have decided significance if derived from large enough number of observations to make its probable error small in comparison to the value of r.

A useful chapter is devoted to harmonic analysis from the standpoint of least squares, including an interesting section on a practical method of investigating periodicities. The last chapter deals with the periodogram, including a treatment of hidden periodicities.

H. L. RIETZ

UNIVERSITY OF ILLINOIS

SPECIAL ARTICLES

THE PRODUCTION OF GASEOUS IONS AND THEIR RECOMBINATION

GASEOUS ionization has played a large part in recent advances in both physics and chemistry. In the ordinary college- and high-school courses given in these subjects little, if any, attempt is made, however, to demonstrate methods of producing gaseous ions or of measuring their recombination or diffusion constants. Practically no laboratory work along these lines by elementary students is attempted. This may be explained in part by the fact that most investigators in this field of research have made use of the electrometer, an instrument well adapted for demonstration purposes but inappropriate for use by the inexperienced student. An electroscope of very simple design has, however, proved entirely satisfactory in place of the more cumbersome and possibly less sensitive electrometer.

Some elementary experiments are suggested in the first part of this paper using apparatus involving little or no expense and which may be assembled by any high-school student. This is followed by a description of some results obtained in verification of the law governing the recombination of the ions of a gas.

PART I

The type of electroscope used is shown in Fig. 1.

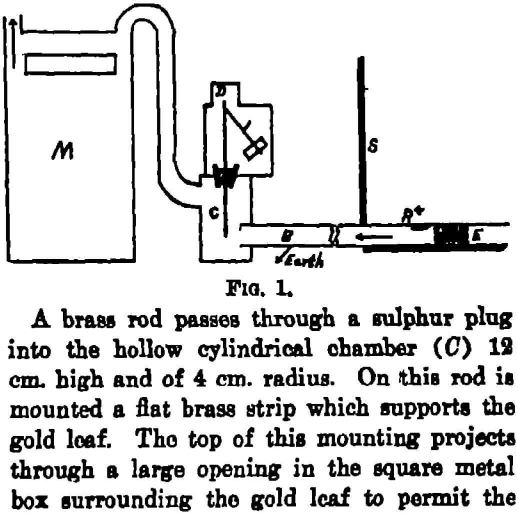

FIG. 1.

A brass rod passes through a sulphur plug into the hollow cylindrical chamber (C) 12 cm. high and of 4 cm. radius. On this rod is mounted a flat brass strip which supports the gold leaf. The top of this mounting projects through a large opening in the square metal box surrounding the gold leaf to permit the electroscope to be charged by removing the metal cap (D). (B) is a brass tube approximately 2 meters long the radius of which will depend upon the laboratory facilities for providing a suitable current of gas. If air ionization is to be studied and compressed air is not available, a suction pump attached to a water faucet will provide a convenient velocity for carrying ionized air through (B) if its radius is of approximately 3 cm. diameter.

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[1] *Phil. Trans.*, 216 A, p. 429.

The velocity of the ions and consequently the time taken for their passage over a given distance may be obtained by measuring the volume of air passing in a given time. A common gas meter (*M*) provided with a dial one turn of which registered one half of a cubic foot was used in these experiments. The air passing through the tube may be dried by calcium chloride and ions prevented from entering with the air stream by a plug of cotton wool placed at (*E*). Lead screens (*S*) should be erected to shield the electroscope from direct radiation. Provided radium salt be used as ionizing agent at a short distance from the electroscope, these screens will need to be several centimeters thick.

The gas passing through the tube may be ionized by X-rays or γ-rays shot through a slit (*R*) cut in the tube and covered by a thin mica sheet, or the ionizing source may be placed inside the tube. A 2 or 3 mm. spark between the secondaries of an induction coil sealed into the tube provides a convenient source of ionization for demonstration purposes. X-rays also produce powerful ionization effects. A 2-inch X-ray bulb run at dull luminescence by a coil capable of producing a 4 cm. spark will provide sufficient ionization for the experiments described below.

A Nernst lamp is more suitable for projecting the gold leaf on a screen than the ordinary lantern. For laboratory work a low powered microscope with a divided scale in the eye piece is used for measuring the rate of fall of the gold leaf.

An electroscope of the type shown in Fig. 1 may be made of comparatively small capacity. If the leaf be charged to a relatively high potential, it becomes an instrument of high sensibility. Owing to the extremely small mass of the gold leaf it will rapidly alter its rate of deflection as the number of ions swept into the chamber changes.

Place the X-ray bulb directly over the electroscope and charge the gold leaf, by means of an ebonite rod, till it shows large divergence. Run the bulb for an instant and the gold leaf at once drops a distance proportional to the ionization produced in the electroscope by direct radiation. If the charging cap is not replaced before starting the bulb, the sudden drop takes place as before, but the leaf instead of stopping its motion as suddenly as it began gradually slows up with time. This effect is produced by the ions in the air surrounding the electroscope rapidly diffusing into it, the number diminishing as recombination takes place. Some idea of the rapidity with which the leaf comes to rest may be obtained from Table I. The numbers represent readings on the scale between the intervals stated in the first column. The readings with 3 second intervals were observed and recorded without assistance. Shorter intervals required assistance in making the record.

TABLE I

Interval	Exp. 1	Exp 2	Exp. 3	Exp 4	Exp 5	Exp. 6
3 secs.	9	17	7	28	34	55
	21	28	15	43	41	74
	27	33	19	49	45	78
	30	36	22	53	47	80
	31.5	38.2	24	55.5	48.5	81 2
	32.5	39.5	24.8	57	49.2	81.8
2 secs	59	48	74	65	84	29
	65	54	80	71	88	33
	70	57	84	74	91	35.5
	73	59 5	87	76	93	36.6
	74.8	60.5	88.5		93.8	
					94 5	
1 67 secs.	71	75	77	68	64	32.5
	74.5	79	79 5	71	68	36.5
	76.4	82	80	72.3	70	39
	77 4	83	80.8	73.5	71.6	40
		84.2	81.2		73	
		84.6			73.6	

Place the X-ray bulb over the slit as indicated in Fig. 1 and start the suction pump. When the radiation passes through the slit large quantities of positive and negative ions are produced in the air stream directly beneath. If the bulb is but a short distance from the electroscope and the air velocity is high, a large proportion of the ions originally produced will be swept into the chamber causing a rapid rate of fall of the gold leaf. The remainder have either recombined or diffused to the side of the tube. Since the negative ions diffuse more rapidly than the positive, the tube should be earth connected. When the bulb or spark gap is 2 or 3 meters from the electroscope and the air velocity is diminished, a considerable time will elapse before any of the ions can reach the electroscope and these will be but a small percentage of the number originally present.

As the first ions arriving are swept into the chamber of the electroscope the leaf begins to move and its rate of fall increases and finally reaches a constant value which is maintained until a short time after the X-rays (or spark) is stopped, following which the rate of leak slowly reduces to zero. The apparent slowness of the leaf in starting and stopping is largely due to the effect of friction between the air and the inner surface of the tube. This appreciably diminishes the velocity of the air in that region, so that on starting, ions passing through the central portion of the tube arrive first. After the rays are stopped, ions near the surface trail along behind, gradually decreasing in number as recombination and diffusion proceed. The effect will of course vary with the length, diameter and material of the tube and the velocity of the air. It will later be shown that this irregular distribution of ions in the tube may affect the value obtained for the recombination constant. For high velocity and a short length of tube the leaf starts at once with a uniform rate of deflection and stops abruptly. Using a spark gap 2 meters from the electroscope and a slow air current, a relatively large rate of leak was observed after 35 seconds had elapsed between the stoppage of the spark and the arrival of the first ions in the chamber.

The rapidity with which gaseous ions diffuse may be well illustrated by inserting a compact bundle of tiny, thin-walled metal tubes inside the tube near the slit. These should be soldered together and make good contact with the inner surface of the tube. Diffusion takes place so rapidly, as the ions pass through the tubes, that with the same air velocity and ionizing source, the number of ions reaching the electroscope is enormously diminished.

The effect of water vapor or dust particles in increasing the ionization, where otherwise the conditions of experiment remain unchanged, is easily demonstrated.

PART II

Experimental Proof of the Law of Recombination

Rutherford has shown that the rate of recombination, at a given instant, of the ions produced in gases exposed to X-rays[1] and the radiation from uranium[2] is proportional to the square of the number present at that instant, from which it follows that

$$\frac{1}{n}-\frac{1}{N}=at,$$

where N and n are the number of ions present in the gas at the beginning and end of time t, respectively. This law has also been verified for gases exposed to X-rays by McClung[3] also by McClelland[4] using arcs and flames as the ionizing agents.

The method most generally employed when large quantities of the gas are available has been to pass the ionized gas through an earthed metal tube with constant velocity and measure the saturation currents at different points along the tube by means of an electrometer. A gas meter was used to measure the velocity through the tube as already intimated.

The deflection of the electrometer indicates the number of ions in a certain portion of the tube at a given instant. The fall of the gold leaf of an electroscope is, however, an integrating process like that of the gas meter and continues over a considerable time for each reading.

If the ionizing agent or the velocity of the ions themselves should undergo slight changes, the rate of fall of the gold leaf would give a good indication of the average number of ions passing at a given time. The sensibility of the electroscope will also remain fairly constant over long intervals and is readily tested.

In the course of some work involving the use of X-rays and γ-rays from radium salt, it was necessary to measure their relative ionizing effects at a given point in air. This was accomplished by sucking the ionized air from the vicinity of the given point through a metal tube into the chamber of an electroscope placed at some distance, as shown in Fig. 1. By noting the rate of deflection of the gold leaf for different air velocities curves corresponding to decay curves were plotted, using ionization in divisions per minute as ordinates and the times of passage of the ions through the tube as abscissæ. By continuing these curves back to zero time an approximation was obtained of the relative ionization originally present. A more exact estimate was made by obtaining the recombination constants for the two ionizing agents and, assuming the square law, calculating the original ionization when the ionization after a given time was known. This work suggested a further study of the recombination constants by this method, using various ionizers, and an examination of the recombination constants for ions produced by "hard" X-rays or the more penetrating γ-rays as compared with these values for the softer and less penetrating radiations.

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[1] Rutherford, *Phil. Mag.*, V., 44, p. 422, 1897.

[2] Rutherford, *Phil. Mag.*, V., 47, p. 142, 1899.

[3] McClung, *Phil. Mag.*, VI., 3, p. 283, 1902.

[4] McClelland, *Phil. Mag.*, V., 46, p. 29, 1898.

Before using the electroscope as an indicator of the number of ions present at any instant, it was necessary to determine the deflection to which the gold leaf must be charged in order to obtain saturation conditions for the maximum velocity utilized. This was found by passing the ionized gas through the chamber of the electroscope to be used, then through the chamber of a second electroscope of high sensibility in close proximity to the one to be tested. The gold leaf of the latter was then charged to a potential sufficient to give no leak in the auxiliary electroscope. For lower potentials ions escaped into the second electroscope and the rate of leak of the first did not give a true indication of the number of ions passing into it. When the potential to which the leaf is charged is considerably lower than that necessary for saturation the decay curves obtained may show a maximum point, since there may be a critical velocity at which a maximum number of ions will give up their charges to the electroscope. At such a velocity the gain in the number entering the chamber will be counterbalanced by the number escaping without giving up their charges.

The order of experiment was then as follows: Determine the saturation potential necessary for a given position of an ionizing agent at the maximum velocity to be used. Obtain the natural leak of the electroscope when the ionizing agent was present, but with no current passing through the tube. Obtain rates of deflection of the leaf in divisions per minute for each of as large a number of different velocities as time and the capacity of the suction pump would permit. The leaf was charged to a given deflection and allowed to leak over the same number of divisions for each reading. The mean of several observations was taken at each velocity. Successive times for the flow of .5 cubic foot of gas through the meter at a given velocity were also recorded. These values were then plotted using ionization in divisions per minute as ordinates and cubic feet per minute as abscissæ. From the smooth curve thus obtained a number of points were chosen and the time of decay of the ionization to these given amounts calculated from the rates of flow. Two of the ionization values were then selected as representing N and n in the formula

$$\frac{1}{n}-\frac{1}{N}=at,$$

where t was the difference between the calculated times of decay for the values chosen. Thus assuming the recombination law, a the recombination constant was calculated in arbitrary units. Using this value for a, a number of values for n were computed and compared with the experimental values. The ionizing agent was then placed at different distances from the electroscope and similar decay curves plotted as a series of checks and with the purpose of obtaining a better idea of the part played by diffusion. This was repeated for brass tubes of different diameters, using X-rays, γ-rays, electric sparks and black oxide of uranium as exciting agents. Air, carbon dioxide and oxygen were used as sources of ions. Decay curves were also obtained, using the arrangement shown in Fig. 2.

Air, oxygen or carbon dioxide under pressure was passed into a large metal cylinder (*H*) approximately 2 meters long, thence through two Wolff bottles (*F*) and (*E*) containing sulphuric acid and cotton wool, respectively, into the tube (*B*). The acid was used as a drying agent and the cotton wool to remove the ions produced by bubbling. This experimental arrangement permitted large velocities through tube (*B*).

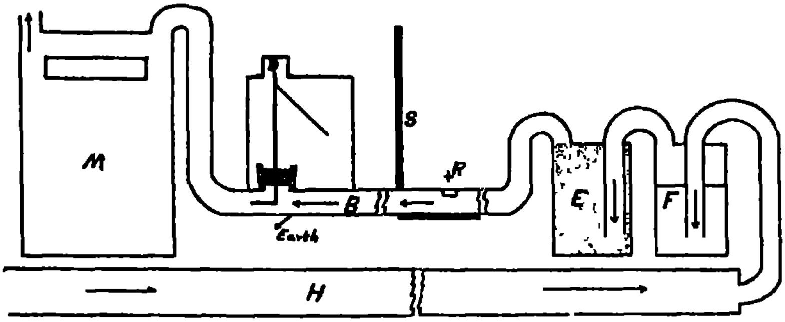

FIG. 2.

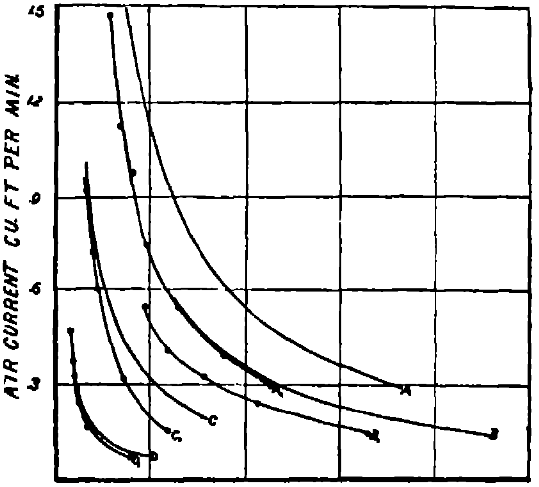

FIG. 3.

The natural leak of the electroscopes used throughout this work varied between .18 and .22 div. per min. with no ionizing agent present. With velocities of 2 cu. ft. per min. through the tube the leak of the electroscope due to ions escaping through (*E*) was less than .04 div. per min.

In some preliminary work it was found that, at a given velocity, ions passed through the tube in a shorter time than the time calculated from the rates of flow would indicate.

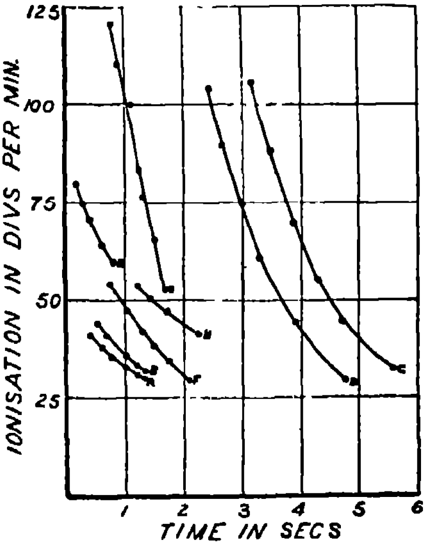

FIG. 4.

Spark gaps were sealed into the tube at different distances from the electroscope and times elapsing between the starting of the spark and the beginning of the motion of the gold leaf were measured by a stop watch. For short distances, the difference between observed and calculated times was negligible; for greater distances at slow velocities, the calculated times were considerably greater. In Fig. 3 curves are given, using rates of flow in cu. ft. per min. as ordinates and time in secs. as abscissæ.

radiation from uranium is so easily absorbed by air that the recombination constant obtained for this cylinder when placed in the tube of 2.95 diameter was .0099, a value evidently too large owing to the diffusion of the ions which were largely produced near the surface of the tube.

TABLE II

Curve	Ionising Agent	Source of Ions	Dist. of Ionising Agent from Elect.	Diam. of Tube	Drying Agent
A.	114 mg rad. salt inside tube	Air under pressure	16.8 cm	2.95 cm.	H_2SO_4
B....	.114 mg rad. salt inside tube	Air suction pump	16.8 cm.	2.95 cm.	$CaCl_2$
C.	.300 mg. rad salt above slit	Air suction pump	27.7 cm.	2.95 cm.	$CaCl_2$
D.	.300 mg rad salt above slit	Air suction pump	93.1 cm.	2.95 cm.	$CaCl_2$
E ...	114 mg rad salt inside tube	CO_2 under pressure	16.8 cm.	2.95 cm.	H_2SO_4
F .	113 mg rad salt 1 cm above slit	Oxygen	29.0 cm.	2.95 cm.	H_2SO_4
G. .	*X*-rays	Air suction pump	125.3 cm.	2.95 cm	$CaCl_2$
H..	Uran cylinder	Air under pressure	40.5 cm.	5.2 cm.	H_2SO_4

Curves *A* and A_1 are plotted, using the calculated and observed times, respectively, for ions to pass 121.4 cm. through a brass tube of 5.4 cm. diameter. Curves B, B_1; C, C_1; D, D_1 are plotted, using calculated and observed times for ions to pass 246 cm., 109 cm., and 25.4 cm., respectively, through a brass tube 2.95 cm. in diameter. For a brass tube 1.12 cm. in diameter, with the spark gap placed 226. cm. from the electroscope, for rates of flow greater than .25 cu. ft. per min. the difference between the calculated and observed times was less than .1 sec.

Sample decay curves are shown in Fig. 4. Observed times of passage of the ions through the tube were used as abscissæ rather than the times calculated by means of the meter from the rate of flow. Experimental conditions under which these curves were obtained are recorded in Table II.

The radium salt used in these experiments was contained in tiny aluminum tubes .7 mm. thick and approximately 2 cm. long. These were sealed into thin glass tubes to prevent leakage of radium emanation, and when used inside the brass tube were suspended at its axis by silk threads. The uranium cylinder referred to under *H* in Table II. was a hollow paper tube 5 cm. long and 2.9 cm. in diameter, with a coating of black oxide of uranium glued on the inside. This cylinder was suspended in the middle of the tube. The *a*

McClung[8] has shown that the recombination constant does not change with the pressure of the gas. Under the experimental arrangement of Fig. 2 the number of ions produced would change with the gas pressure and introduce a small correction for large capacities. Investigation showed that this change, if assumed to be linear, would be negligible for all capacities used.

FIG. 5.

Fig. 5 shows the pressures in tube *B* for various air currents. The barometer reading was 75.35 cm. At 1.6 cu. ft. per min. the curve shows the correction to be .2 per cent.

Table III. contains the observed ionizations in divisions per minute for the above curves of Fig. 4, also the calculated values obtained

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[8] *Loc. cit.*

TABLE III

Curve	Vel. in Tube in Cm. per Sec.	Exp. Ionisation in Divs. per Sec.	Calc. Ionisation in Divs. per Min.	Recombination Constant. *a*
A...	42	*40.9	41.1	Mean value .0105
	28	38.0	38.4	
	22	35.8	35.6	
	16.5	32.8	32.5	
	14.0	30 8	30.4	
	12.5	29.8	29.2	
B..	32	*44 0	44 0	.0107
	25	40 9	41.2	
	16.5	*35.8	35.8	
	14	33.6	33 2	
	12	31.8	31 8	
C. ...	30	*121	121	.0097
	24	94.5	89.0	
	19	83.4	79 3	
	17	76 5	75.7	
	16.5	*65.5	65 5	
	14	53.0	59 8	
D	28	*103.8	103 8	.0081
	25	89.4	89.5	
	22	74 6	72.0	
	19	*60 6	60.6	
	17	44.4	46.5	
	14	29.4	35 0	
E.	47	*79 8	79 8	.0071
	45 3	74 8	74.4	
	27.6	*64.0	64.0	
	20.7	59.5	58 5	
	13 8	53.0	57.7	
F.	39	*54.0	54 0	.0094
	27.6	47 2	46.7	
	22	*42.0	42 0	
	19 3	38.4	39.2	
	16 6	34 5	35.8	
G.	30.4	*105.5	105 5	.0088
	24 8	69 0	65 5	
	19.4	44.5	43.0	
	16.6	*32.4	32 4	
H.	24.1	*53.9	53.9	.0057
	18.4	50.1	50.3	
	15.3	47.0	46 7	
	11.5	41.4	40.7	
	10 3	*38.3	38.3	

by assuming the square law. The effect of diffusion at the lower velocities is well shown by the way in which the observed values fall below the corresponding calculated results. The values used in each experiment for calculating the recombination constant are marked by an asterisk.

In Table IV. the observed and calculated values are given for X-rays as an ionizing agent at a distance 27.7 cm. from the electroscope for an air current through a brass tube 2.95 cm. in diameter, using the arrangement of Fig. 1.

Vel in Tube in Cm per Sec.	Exp. Ionisation in Divs. per Min	Calc. Ionisation in Divs. per Min.	Recombination Constant, *a*
26 2	*224	224	.0099
22	182	182	
19	150	149.2	
16 6	*121	121	
15 2	105	101	
14 0	90	08	

An attempt was made to see if the recombination constant was a function of the quality of a given radiation. X- or γ-rays were shot through the slit, first bare, then covered by foils or sheets of lead. A series of decay curves were thus obtained and the recombination constants calculated. Values were obtained with the slit bare at the beginning and end of the series to check the constancy of the sensibility of the gold leaf. The slit was covered at all times by a mica sheet .03 mm. thick.

TABLE V

Thickness of Lead Over Slit	Vel. in Tube in Cm per Sec.	Exp. Ionisation in Divs. per Min.	Calc. Ionisation in Divs. per Min.	Recombination Constant
Slit bare	30 0	*121 0	121 0	0097
	24 0	94 5	89 0	
	19 0	83 4	79 3	
	17 0	76 5	75 7	
	16 5	*65 5	65 5	
.15 mm.	27 6	*76 0	76 0	012
	22 0	62 0	59 8	
	19 3	55 3	55 3	
	16 6	*48 4	48 4	
	13 8	42 5	43 6	
20 mm.	30 0	*79 6	79 6	0147
	27 6	72 4	71 3	
	20 7	54 0	55 0	
	16 6	*43 0	43 0	
	13 8	37 3	39 5	
.40 mm .	29.0	*73 8	73 8	0164
	27 6	70 6	69 8	
	24 8	55 0	52 0	
	14 6	*40 7	40 7	
1 2 mm ...	27 6	*64 0	64 0	019
	24 8	46 5	47.7	
	22 1	40 8	42 5	
	16 6	*36 0	36 0	
2 4 mm .	27 6	*53 7	53 7	.0221
	22 1	42 2	40 0	
	19 3	37 0	36.1	
	16 6	*30.8	30 8	
Slit bare	30 4	*133 0	133 0	.0096
	20 7	86 0	84 3	
	19 3	80 4	80.5	
	16 6	*69 0	69 0	

Table V. contains the results of such a test for air as the source of ions in a brass tube of 2.95 cm. diameter and .300 mg. of radium salt as the ionizing agent placed at a distance 27.7 cm. from the electroscope and approximately 1 cm. above the slit.

TABLE VI

Thickness of Lead Over Slit	Vel in Tube in Cm. per Sec.	Exp. Ionisation in Divs. per Min.	Calc. Ionisation in Divs. per Min.	Recombination Constant. α
Slit bare.. .	24.8	*210	210	.0086
	19.4	150	156	
	16.6	*121	121	
	15.2	105	108	
	13.8	90	102	
.05 mm.....	24.8	*98.2	98.2	.015
	19.4	68.0	68.0	
	15.2	*46.2	46.2	
	13.8	40.1	42.6	

Table VI. gives results obtained for X-rays as ionizing agent, the slit being placed 27.7 cm. from the electroscope, with an air velocity in the brass tube of 2.95 cm. diameter. Table VII. records values for an X-ray ionizing source at 125.3 cm. from the electroscope, other experimental conditions remaining the same.

TABLE VII

Thickness of Lead over Slit	Vel. in Tube in Cm per Sec	Exp Ionisation in Divs. per Min.	Calc Ionisation in Divs. per Min.	Recombination Constant· α
Slit bare. ..	30.4	*105.5	105.5	.0088
	24.8	69.0	65.5	
	19.4	44.5	43.0	
	16.6	*32.4	32.4	
.05 mm. . .	31.8	*68.2	68.2	.00923
	26.3	52.4	48.0	
	19.4	*33.2	33.2	
	18.0	28.5	29.4	
	15.2	21.8	23.7	
.1 mm	21.8	*31.7	31.7	.020
	26.3	24.7	26.7	
	23.5	20.3	20.2	
	18.0	*14.9	14.9	
	16.6	13.8	13.5	
Slit bare.	30.4	*102.5	102.5	.0080
	23.5	63.2	59.5	
	18.0	*38.8	38.8	
	15.2	27.2	30.8	

The lack of saturation in the electroscope for large ionization currents would tend to give too small a value for the recombination constant, while diffusion effects at the smaller velocities through the tube would increase it. Neither of these causes, under the experimental conditions, would appear to be sufficient to explain the larger values obtained for the recombination constant for the more penetrating radiations.

I am indebted to the Providence Gas Co. for the gas meter which was used, also for its careful calibration before and after the experiments.

P. B. Perkins

Brown University,
June 28, 1917

BOSTON MEETING OF THE AMERICAN CHEMICAL SOCIETY. III

DIVISION OF BIOLOGICAL CHEMISTRY

C. L. Alsberg, *Chairman*

I. K. Phelps, *Vice-chairman and Secretary*

The relation of the dissociation of hydrogen to enzymatic activity: Howard T. Graber and J. W. M. Bunker. It was demonstrated that the enzyme "pepsin," in agreement with the other enzymes, invertin and catalase, has an optimum at a definite H. ion concentration and that the presence of other ions exerts an influence which is not measurable, yet not negligible. It was shown that in the case of the weakly dissociated organic acids the buffer effect of the protein added has a marked effect upon the dissociation of the acids, but that when the concentration of the H ions was made equal to that of 3 per cent. HCl by considering temperature and protein the organic acids are equal to 3 per cent. HCl as activators for peptic digestion.

On the origin of the humin formed by the acid hydrolysis of proteins III. Hydrolysis in the presence of aldehydes II. Hydrolyis in the presence of formaldehyde· Ross Aiken Gortner and George E. Holm. Hydrolysis in the presence of formaldehyde completely alters the nitrogen distribution obtained by Van Slyke's method. Black insoluble humin is formed from tryptophane and no other known amino acid is concerned in the reaction. The primary reaction of black humin formation involves only the indole nucleus and not the α amino group of the allphatic side chain of tryptophane. Formaldehyde forms a soluble humin with tyrosine which is precipitated by $Ca(OH)_2$. Hydrolysis in the presence of formaldehyde causes enormous increases in the ammonia fraction, but the increase is not due to ammonia, but to volatile alkaline compounds. The detailed paper will appear in the *Jour. Amer. Chem. Soc.*

The effect of prolonged acid hydrolysis on the nitrogen distribution of fibrin, with especial reference to the ammonia fraction: Ross Aiken Gortner and George E. Holm. Fibrin was boiled with 20 per cent. HCl for varying periods of time ranging from 1 hour to 6 weeks, the ammonia fraction increases continuously, showing a 150 per cent. increase at the end of six weeks over that obtained at the end of twelve hours. This increase in ammonia comes almost entirely from the deamination of mono amino acids. The ammonia fraction of a twenty-four- or forty-eight-hour hydrolysate can not be taken as an absolute measure of amide nitrogen, for some "deamination" nitrogen is undoubtedly present, the amount depending both upon the particular protein and the length of hydrolysis. The paper will appear in the *Jour. Amer. Chem. Soc.*

Comparative analyses of fibrin from different animals: Ross Aiken Gortner and Alexander J. Wuertz. Fibrin has been prepared from the blood of cattle, sheep and swine and the nitrogen distribution determined by Van Slyke's method. No differences significantly greater than the expected experimental errors were found. It would thus appear that fibrin from any of these three sources can be used interchangeably in experimental work without invalidating the results. Whether or not this is true for fibrins from other sources remains still an open question.

The nitrogen distribution in protalbinic and lysalbinic acids: Ross Aiken Gortner and Cornelia Kennedy. Lysalbinic and protalbinic acids were prepared from egg albumen by Paal's method and their nitrogen distribution, together with that of the original egg albumen, determined by Van Slyke's method. No marked difference was observed in any of the fractions, although both of the derived products show a somewhat greater apparent lysine content. This is probably due to ornithine derived from arginine. The analyses furnish no evidence as to whether or not these "acids" are true chemical compounds or as to whether or not their structure is more simple than is that of egg albumen. The paper will appear in the *Jour. Amer. Chem. Soc.*

On the relative imbibition of glutens from strong and weak flours: Ross Aiken Gortner and Everett H. Doherty. The gluten was washed from both "strong" and "weak" flours and the hydration capacity of the colloids measured by immersing weighed disks in different concentrations of certain acids, allowing them to remain a definite length of time and again weighing. Lactic and acetic acids produced greatest imbibition, the form of these hydration curves being very different from those of hydrochloric and oxalic acids which produced much less hydration. The gluten from a "weak" flour has a much lower *rate of hydration* and a much lower *maximum hydration capacity* than has the gluten from a "strong" flour. Gluten from a "weak" flour changes from a gel to a sol at a much lower degree of hydration than does that from a "strong" flour. There is an inherent difference in the colloidal properties of the glutens from "strong" and "weak" flours and these glutens would not be identical even if the flours had originally had the same salt and acid content. The paper will be published in *Jour. Agr. Res.*

ORGANIC DIVISION

J. R. Bailey, *Chairman*
H. L Fisher, *Secretary*

Joint Session with Physical and Inorganic Division

The composition of oil of cassia. II: Francis D. Dodge. In a previous paper, the writer and A. E. Sherndal have reported the examination of the alkali-soluble portion of the oil of cassia, finding, as new constituents, *coumarin, salicylic aldehyde, salicylic* and *benzoic* acids, and a liquid acid, not identified. The writer has recently examined the aldehydes present in the oil, and has identified, as minor constituents, *benzaldehyde* and *methyl-salicylaldehyde.* The latter was isolated as the oxime, melting at 90°, and identified by conversion into methyl salicylic acid. No positive indication of the presence of *hydrocinnamic* aldehyde was found.

Molecular rearrangements in the camphor series. The decomposition products of the methyl ester of the isoaminocamphonanic acid. A new reaction involving the formation of the methyl ether of a hydroxy acid: William A. Noyes and Glenn S. Skinner. Several years ago L. R. Littleton and one of us were engaged upon the study of the decomposition of isoaminocamphonanic acid with nitrous acid. Cis-camphonololactone was the only product identified. We have undertaken the study of the decomposition of the methyl ester with the intention of separating the products by fractional distillation under diminished pressure. The products that would be normally expected are a methyl ester of a hydroxy (trans-camphonolic) acid with hydroxyl in place of the amino group and a methyl ester of a Δ_4 unsaturated acid containing a gem methyl. Neither of these compounds has been found, but, instead, at least six compounds involving rearrangements. Our results show that the methyl ether and methyl ester of cis-camphonolic acid and the methyl esters of lauronolic acid, 1, 2, 2, trimethyl 1-carboxy cyclopentene-4, cis 1, 2, 3 trimethyl 2-hydroxy 1-cyclopentanoic acid, and a secondary β-hydroxy acid are formed. The method of preparing the materials and a more detailed discussion of the work are reserved for publication in the *Jour. Amer. Chem. Soc.*

The synthesis of certain terpene homologs from 1, 4-diisopropyl cyclohexane: M. T. Bogert and C. P. Harris. Three new homologs of the terpenes have been prepared from 1, 4-diisopropyl cyclohexane. These new terpene bodies contain two olefin side chains in para position and represent hydrocarbons of a somewhat different type from any hitherto described. One is a derivative of an ordinary benzene nucleus, one of a dihydro- and the other of a tetrahydro benzene nucleus. Various properties of these substances are described.

Further studies of o-uraminobenzoic acid, benzoylene urea and related compounds: M. T. Bogert and G. Scatchard. Experiments are recorded with 5-nitro anthranilic acid, o-uranimobenzoic acid, dinitro uranimobenzoic acid, benzoylene urea and various derivatives of the above.

The synthesis of certain substituted pyrogallol ethers derived from syringic acid: M. T. Bogert and J. Ehrlich. These new compounds include a dimethoxy phenacetine whose physiological properties are now being studied at the College of Physicians and Surgeons, and which is at least no more toxic than ordinary phenacetine, and possibly less so; and also a homoantiarol, which is of interest from the fact that it is a homolog of the so-called antiarol isolated from antiaris toxicaria.

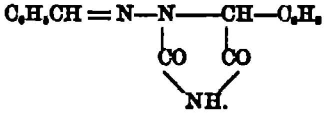
A substance which in the liquid phase exhibits a minimum of solubility in an unstable region: M. T. Bogert and J. Ehrlich. A study of the solubilities in water of monohydrate of 2.6-dimethoxyacetphenetidide discloses the interesting fact that the liquid hydrate is unique in that it exhibits a minimum of solubility in an unstable region.

The identity of cyanuric acid with the so-called "tetracarbonimide": E. H. Walters and Louis E. Wise. The so-called "tetracarbonimide" prepared by Scholtz by the oxidation of uric acid in alkaline solution with hydrogen peroxide is in fact cyanuric acid. A nitrogenous compound isolated from a number of soils and believed at first to be tetracarbonimide has been shown to be cyanuric acid. Cyanuric acid has been isolated from the following soils: (1) 12 samples of sandy soils taken from different locations in Florida; (2) Norfolk sandy loam from Virginia; (3) lawn soil from the grounds of the U. S. Department of Agriculture, Washington, D. C.; (4) Elkton silt loam from Maryland; (5) Scottsburg silt loam from Indiana; (6) Caribou loam from Maine, and (7) a Susquehanna fine sandy loam from Texas. It is apparent that cyanuric acid or its precursor is widely distributed in soil.

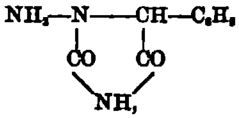
Use of prussic acid in glacial acetic acid: J. R. Bailey and R. H. Pritchett. Preparation of benzalhydrazinophenylacetonitrile, $C_6H_5CH=N{-}NHCH(C_6H_5)CN$, by treatment of benzalazine, $C_6H_5CH=N{-}N=CHC_6H_5$, in glacial acetic acid with solid KCN. Benzalhydrazinophenylacetamide, made from the nitrile, adds on HCNO, giving benzalcarbamylhydrazinophenylacetamide,

$$C_6H_5CH=N{-}N(CONH_2)CH(C_6H_5)CONH_2,$$

which can be converted to 1-benzalamino-5-phenylhydantoin,



By eliminating benzaldehyde from the latter substance 1-amino-5-phenylhydantoin,



is obtained.

Testing of nitrocellulose materials: H. C. P. Weber. A report of work done at the Bureau of Standards in connection with the stability, particularly on cellulose plastics (such as celluloid, pyrolin) although reference is made to explosives. The limits of decomposition, its rate and character, the products resulting, inflammability, explosiveness are taken up with a view to defining the conditions under which such materials become a source of danger. Charts showing the results graphically are given. With the exception of a report published some time ago in a foreign country, very little comprehensive work on this particular phase is available. A government bulletin covering this matter is in preparation.

(*To be continued*)

SCIENCE

FRIDAY, DECEMBER 21, 1917

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MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

THE STORY OF COSMOLOGICAL THEORY[1]

I

IT may be that primitive man felt none of the

> Blank misgivings of a creature
> Moving about in worlds not realized.

For him, perhaps it was enough to taste the joy of living, to watch the rising and the setting of the sun, to gaze upon the mountain, the river and the restless sea, and never to ask himself the question "what is this world in which I live, and how did it come into being?" But this problem eventually presented itself, for there has been implanted within the human breast that which distinguishes its possessor from the beasts which perish, the passion for knowledge, the deep longing for

> Authentic tidings of invisible things,
> Of ebb and flow and ever-during power:
> And central peace subsisting at the heart
> Of endless agitation.

And so there arose those questions about himself, about the visible universe in which he dwelt, and that invisible world about which he dreamed, from which have sprung all that we now call science and philosophy.

How slow and laborious have been the steps by which knowledge has been attained, and how childish and even grotesque the answers to these first questionings. But to have any theory at all for the first causes of things is very much better than to have none, and these crude products of primitive man, and the refined deductions of the modern scientist are the same at heart. Alike they seek to deduce from known facts the underlying principles of nature. If the modern hypothesis appears to lie much nearer to the truth, it is because the facts upon which it is based are more numerous and more completely verified. Nor should we forget that it has had the advantage of a long series of tentative explanations, which it now replaces. All our advances have been made over the remains of discarded theories.

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[1] Opening lecture of the year, delivered at the Autumn Convocation, McMaster University, Toronto.

It is here proposed to trace in outline the history of the theories which from time to time have been suggested to account for the way in which the earth was formed. It will be seen that we have here three stages in human intellectual development. In the first the world was conceived to be due to the literal handicraft of a beast, a demigod or a divinity. In the second it was realized that a nobler origin must be sought, but methods of scientific criticism had not been perfected sufficiently to put the theories to the test. In the third, every one had to be submitted to the most rigid dynamical analysis.

II

In order that these primitive theories may have an unprejudiced hearing it is well for us to try and put ourselves in the place of their authors. Let us view the world as seen through the eyes of the ancients.

At the time of the dawn of consciousness, man found himself on what appeared to be a flat and circular earth. As he extended his wanderings this way and that, although great ranges of mountains occasionally stood in his way, they could eventually be crossed, but sooner or later he seemed always to come to the shores of the impassable sea. So he concluded that the disc-shaped land was completely surrounded by the ocean, which flowed like a mighty river around the earth. Above him was a great dome, forming a lid to it all. This was evidently of solid material, glass or some metal, possibly brass. Some claimed that it must be transparent, others, that it was perforated by windows, for at night the light of the celestial regions shone through, and he called these bright objects stars. The Egyptians had a slightly different explanation, for, according to them, the stars were lamps hanging down from the ceiling of the world on the end of chains. Over this dome he saw passing, with wonderful regularity, various bright objects, notably the sun, and he soon observed, in addition to its regularity, that it had a very rapid motion, for it came up from beyond the River Oceanus, probably through a great door, in the morning, and in about twelve hours had crossed the dome of the heavens and was at the door of the evening, ready for its return journey through the upper world down to the gate of the morning once more. This rapid journey, in the days before steam or gasoline, could be explained only by the use of swift animals, and what animals are so swift as horses.

Above the dome of the heavens there seemed to be another ocean, for ever and again the roof leaked and showers of rain fell upon the earth. It was evident also that there must be beings there who controlled the activities of nature, and probably they could occasionally climb down by way of the sides of high mountains, whose tops, inaccessible to man, undoubtedly touched the sky, and indeed, probably helped to support it.

Now all the mysterious and terrifying forces of nature were to be explained in a perfectly naturalistic way, by the intervention of these beings from the upper world. Was the oak under which our forefather had taken refuge in a storm, shattered by the lightning, it was because one of the gods had hurled a flaming dart.

Was he unfortunate enough to receive into his veins the poison of malaria, it was because an evil spirit had entered into him and had to be induced to come out by a bribe, or driven out by the use of mystic combinations of words which were calculated to cast a spell over it. So when the author of creation was thought of it was in the form of an animal like those he hunted, but much bigger. A turtle, swimming in the primeval ocean, dives down, as he had often seen it, and, coming up, bears upon its back some of the mud from the bottom, and on this, trees grow and living creatures move and among them all, himself. At times the load grows heavy, and the turtle moves, and the earth quakes, and perhaps some day the whole will slip again beneath the waves.

Or, again, a number of animals have escaped the destruction of a previous earth on a raft. They float for many days upon the face of the waters and find no place for the soles of their feet to rest. They take turns at diving in order to bring up some earth from the bottom, but it is not until several of them had essayed the task that a grain of sand is recovered. From this they mold the new earth, and then disembark and a new era commences.

These simple theriomorphic tales are found among the less advanced races. In the minds of those who had observed more carefully, and thought more deeply, profounder ideas began to prevail. To the thinker of Neolithic times, as indeed to him of to-day, one of the most wonderful things in nature is an egg. Within this thing, apparently so simple in its constitution, there is developed, and that in the course of a very short time, all the complexity of structure of reptile or bird. Perhaps even he dimly realized that all things living proceed from an egg. It was evident also that the order of nature is from the simple to the complex, and the world, in its marvelous complexity, is no doubt, he thought, a living thing. What would be more natural, then, than that the world itself is the final product of the development of an egg? This theory is found again and again in the mythologies of ancient races, persisting even among the stories of a nobler cosmogony. Thus in the Book of Manu, in Indian Classics, we read "the self-existing lord, with a thought, created the waters, and deposited in them a seed which became a golden egg, in which egg he himself is born as Brahma, the progenitor of the world."

III

We have now come to the stage in human development when it was no longer necessary to explain the origin of the world in terms of beasts or demigods. A new theory now had to be formulated in the light of increased knowledge and broader mental grasp. To some it may have appeared that things had always existed as they are, but the philosophical necessity for an explanation of origins early impressed itself upon the minds of the Greeks, who were the first to devote themselves to such speculations.

Two alternatives formed the foundations for the theories of two opposing schools of thought, the one of monism, the other of dualism. To Leucippus and Democritus and their disciples the world appeared to have been the result of a fortuitous concourse of atoms. Behind it all they saw no plan, no intelligence. This was the underlying concept of the great poem "De Rerum Natura" of the Latin poet Lucretius, who lived in the first century B.C. He tells us:

> Nam certe neque concilio primordia rerum
> ordine se suo quaeque sagaci mente locarunt
> (5: 419),

which may be translated:

For verily not by design did the first-beginnings of things station themselves each in its right place by keen intelligence.

To Plato and his school, on the other hand, the orderly course of nature can be explained only as the incarnation of a divine plan. So he conceived of the universe before the creation as consisting, on the one hand, of chaos and disorder, matter without plan or qualities; on the other hand, of the eternal plan or soul of the world existing in the mind of God. Then the creator, taking this inert nothingness, impressed upon it the eternal idea and the whole becomes an organic unity.

Thus the universe was created, unchanging, unchangeable, and this idea, as modified by Aristotle, became the current coin of the intellectual world. Nearly twenty centuries passed before the next advance came with the realization that the world did not spring into existence full grown, but that its present state is the result of a long series of changes.

IV

Before this idea of progressive development could be attained, it was necessary that certain hoary fallacies should be cast aside and correct notions substituted. Until it was realized that the earth and the other celestial bodies are spheres, and that the sun, and not the earth is the center of our own system, the progress of astronomy and cosmology were slow and imperfect. But these were concepts of very gradual growth.

In the early part of the fifth century B.C., Parmenides, of Elea, wrote a short poem on Nature, of which we still possess a few fragments. In this he refers to the spherical form of the earth, a truth which he appears to have been the first of all mankind to enunciate. Around the earth as a center he conceived a series of concentric spheres on which were fixed the heavenly bodies, an idea which was not without its supporters during the following two thousand years. A little later it seems to have been taught by Pythagoras. From it his disciples and successors framed their interesting theory of the Cosmos, which was believed to consist of the "central fire," the "hearth of the universe," round which were ten concentric spheres. There must be ten, for the system is perfect, and according to their idea, ten is the number of perfection. These spheres bear in succession the fixed stars, the five planets, the sun, the moon, the earth and another celestial body, which they called the "antichthon" and which served as a screen between the earth and the central fire. Around this blazing pivot revolved the earth once in 24 hours, always facing outwards, and so bringing into view the various parts of the heavens in succession. Consequently the back of the earth must always be dark. Therefore, if one were to travel past India, there he would find a land of perpetual twilight, where neither the blessed light of the sun nor the rays from the central fire could ever penetrate.

The spherical form of the earth was subsequently taught by Plato, who, like all that followed for two thousand years, placed it in the center of the universe, and finally, by Aristotle, who became, until the Renaissance, the dominating figure in European thought.

But the development of correct cosmological ideas was not destined to continue uninterruptedly. In 389 the great library of Alexandria was destroyed. Shortly after came the fall of the Western Empire and the long, dark night of the middle ages set in. Most of the gains which science had made during the previous centuries were forgotten, and the Church, which then became the custodian of all that was thought worthy of preservation, set its face firmly against the learning of the pagan Greeks. A new theory of the universe, according to a plan which would follow their interpretation of the Holy Scriptures, consequently appeared to be a desideratum. The great task of inventing this fell to Cosmas, surnamed, on account of his extensive travels, Indicopleustes, the Indian voyager. According to him, since the Epistle to the Hebrews expressly declares that the inner tabernacle was a pattern of the Kingdom of Heaven, it follows that, if we would understand the construction of the universe, we can find it epitomized in the description of its antetype in the Book of Exodus. The table of shewbread with its wavy border represents the earth surrounded by the ocean. Therefore the earth is rectangular, twice as long as it is broad, its longer dimension extending east and west. Beyond the ocean, as is clearly proved by the existence of an outer border to the table, lies another land where is situated the earthly paradise. That other was the home of mankind until the flood, and then Noah sailed across. But since that day the return journey has become impossible, owing to the tempestuous weather which ever prevails upon the ocean. We who actually live in trans-oceanic lands may be permitted to disagree on some points with the learned theologian, for we have found neither the terrestrial paradise nor the tree of life which it contained. At the edges of this other earth were erected the walls of heaven topped by a roof shaped like half a cylinder. But it is a two-storied building, is the universe, and the firmament forms the division which is at once the roof of the world and the floor of heaven. Above the firmament are the abodes of the blest.

The motions of the heavenly bodies are to be explained by the activities of the angels. They carry the stars in orderly succession over the heavens. They also carry the sun. Now the northern part of the earth is very high, in fact rising to an exceeding lofty mountain, and on their return journeys the sun by night and the stars and moon by day are borne by the angelic host behind the mountain and so are not seen. In winter they go with the sun near the base, and night is long; in summer near the top and night is short.

This famous system of Cosmas, the crowning absurdity of medieval science, the culminating flower from seeds of wilful ignorance, was indeed the climax of the anti-scientific spirit. After this the old ideas of the constitution of the universe once more began to be critically studied, and once more the wheels of progress, for many centuries almost stationary, began to move.

For the first hypothesis of a universe which revolves around the sun, we must go back many ages. In the third century before Christ, Aristarchus of Samos first conceived this great truth. How he arrived at this he has left us no explanation. A century later a Babylonian named Seleukis reaffirmed the diurnal motion of the earth, but for the most part, for 1,700 years, the voice of Aristarchus was as of one crying in the wilderness.

Then came Copernicus, one of the world's great geniuses. In the work of his predecessors one must search diligently to find the grain of truth among much chaff, but with him the system of the universe was revealed with great clearness. This, substantiated by the work of Kepler, of Galileo and of Newton, has formed the basis of all subsequent progress.

V

When once the nature of the sun had begun to be understood, and the stars were seen to be, like it, fiery orbs, it was natural that men should begin to think that the earth itself, now seemingly cold, might have been a fiery mass. This idea was first suggested by Descartes in his "Principia Philosophiæ," published in 1644. According to him, the earth, like every other celestial body, was formed by the aggregation of primitive particles of matter which have an inherent whirling motion. The resultant sphere, after it has changed from the gaseous to the molten condition, cools and becomes covered by a solid crust. But the central portion still retains its hot and plastic condition, which is manifested by the phenomena of mountain-building and vulcanism.

Leibnitz, thirty-six years after, in his "Protogœa," which, however, was not published until after his death, followed an almost identical hypothesis, conceiving the earth to have been built up of an aggregation of whirling ultimate elements or "monads" of matter. But while Descartes looked upon the motion as being due to the momentum supposed to be present in constant amount in the universe, Leibnitz believed it to be due to the force which accompanied the separation of light from darkness.

Later this doctrine was carried a step farther by the philosopher Kant, and finally by Laplace in his theory so modestly put forward, which has since become so famous under the name of "the Nebular Hypothesis."

Briefly stated this hypothesis predicates the origin of our solar system in a great fiery mass of incandescent vapor, similar to the nebulæ, which are among the most wonderful objects revealed to us by the telescope. The parent nebula of our system must have extended far past the present orbit of the outermost planet, Neptune, then undiscovered. In order to fill this space the matter available must have been spread out extraordinarily thin; in fact, the density would be one millionth of that of the air we breathe. The whole was subject to a rotary motion. As time passed, heat was radiated into space, and, as the tenuity was maintained by heat, the mass became cooler and denser. Particles on the circumference would thus steadily move closer in to the center. Now the velocity of any such particle would remain unchanged, while the distance it would have to travel in order to complete the journey around the center, would steadily grow less. It follows that it would be whirling around the axis at an ever-increasing rate, and consequently, with an ever-increasing tendency to fly off into space. At the same time the pull of gravity, since the particle is closer to the center, is constantly growing greater. It is then subject to two steadily increasing forces, one of which tends to throw it off, the other to drag it down. A time will come when these two forces will just balance and the particle will go up neither nor down, but remain revolving in an orbit. The total result of this on all the particles of the outer zone would be to leave them in the form of a ring of gas. Similarly, the same process would be followed in the case of another zone, until the whole would resolve itself into a central spherical nebula surrounded by a series of rings. Each ring in turn would soon break, and the gas of which it was composed would come together in a revolving sphere, which might give rise to other rings. The system is constantly cooling, and the spheres of gas, finally solidifying, give rise to the planets and satellites.

The simplicity and grandeur of this theory fire the imagination. It is no wonder that it took firm root. For several generations it was received without reservation. Gradually, however, serious defects began to be seen. For instance, if we calculate the rate of motion of the molecules of such a system, the temperature and rate of rotation of the whole being known, it can be proved that this motion would be so great that the force of gravity, even of so great a mass, could not prevent them from flying off into space and so being lost.

Again, it can be calculated from the facts at our disposal, where the rings would be left by such a cooling nebula. It is then found that the first ring, instead of being in the position of the present orbit of Neptune, would be inside the orbit of the inmost planet, Mercury. Where fact and theory do not agree, so much the worse for theory.

These are typical of the numerous and insuperable objections to the acceptance of the hypothesis. Within the last few years, the belief has been gaining ground among astronomers and geologists that this theory, so long the accepted one, must in its turn be discarded.

The cogency of the difficulties which have presented themselves whenever the theory of Laplace has been critically studied cleared the way for the meteoritic theory as presented by Lockyer and modified by Darwin. But here again the objections raised are so many and so reasonable that it stands on no surer a foundation than its predecessor.

Of recent years, the Planetesimal Theory of Chamberlin has been gaining ever-increasing support. Like the authors of preceding theories, he scanned the heavens for facts which might have a bearing upon the problem in hand. He saw, like them, the brilliant masses of "star dust" which we call nebulæ, but he saw also the importance of the fact that there are two distinct kinds of nebulæ. One kind, sometimes spherical, sometimes irregular in shape, is composed of incandescent gas; the other, consisting of two tightly coiled spiral arms, is evidently made up of solid particles. In the latter only do we find indications of the important metallic elements which occur in the earth.

This suggested to him that the parent nebula of our solar system was probably one of the spiral type, and his first problem was to account for the origin of such a nebula. An occurrence, famous in the history of astronomy, has an important bearing upon this. Nearly 350 years ago (November, 1572), Tycho Brahe, the famous Danish astronomer, was very much astonished to observe a new star in the constellation Cassiopeia. An hour before he had scanned that part of the heavens and saw nothing, and when he looked again there it stood, a star of the first magnitude. From night to night it grew in magnificence, surpassing in turn the fixed stars, the planets, even Venus at her brightest, until it could be seen at noonday. It had now become the most glorious and brilliant orb in the heavens, giving, it has been calculated, 100,000 times as much light as our sun. Then this strange luminary slowly faded away, nightly becoming less brilliant, until, after the lapse of 17 months, it sank into final darkness.

How is this astonishing phenomenon to be explained? The general belief is that it was probably due to the collision of two great celestial bodies. Their energy of motion was changed into molecular energy, and the elements melted with fervent heat. So hot indeed did they become, that a great cloud of incandescent gas was the result, whose molecules were moving at such rapid rates that they were whirled away into space and so disappeared. Other stars of this kind have frequently been observed since then, but never has one so brilliant been recorded.

Now it may be that we have here a typical example of the formation of a gaseous nebula, though but a temporary one. Had the impact been less violent it might have been permanent. But what would have been the result if the bodies in question had not actually collided, but had passed very close to one another? It can be demonstrated mathematically that such an approach would entail the formation of two prominences, on each body one at the point of least distance apart, and one diametrically opposite. If the approach be close enough, these prominences may be drawn out into the form of two long arms composed of discrete particles. As these bodies pass, each, by the pull of its gravity, will communicate to the other a rotatory motion which will result in the coiling of the arms. These will be composed of large numbers of comparatively small particles, each of which is revolving in a regular orbit around the central nucleus of the system. These particles, resembling in their constitution meteorites, have been named planetesimals, and hence the name of the hypothesis.

Now, while the whole is rotating and has the form of a spiral swarm, the tendency will be for the planetesimals to come together and form a series of nuclei in the arms, which, as they grow by accretion, become solidified and form the planets. In our present stage, most of them have been gathered in. A few are still falling as meteors, but the addition from this source to the size of the earth is quite insignificant.

This is the famous Planetesimal Theory. It explains the phenomena better than any other which has yet been suggested. But it may be that this, too, will eventually go the way of past theories, and its place taken by another newer one. It is too much to believe that we have now reached finality, and that our hypothesis outlines the actual physical facts of our earth's history.

Certain recent observations already suggest a somewhat different organization of the universe than that on which this theory is based. It has been pointed out by Campbell that while the gaseous nebulæ are to be found mainly in the direction of the Milky Way, the spiral nebulæ are never seen in these parts of the heavens but are numerous in directions at right angles. Now the stellar system is looked upon as being of a discoidal shape, and what we call the Milky Way is merely the direction of greatest depth and consequently of closest distribution of the stars. It follows that at right angles to this we look through the stellar system and out into infinite space, and it may be that the spiral nebulæ which are to be seen in these directions are not within our stellar system at all. Measurements of their motion towards and away from us indicate that they are moving at very rapid rates, probably as great as 500 miles per second, a very much greater speed than that of any known star. And yet, when their relative positions in space are compared with those they occupied fifteen years ago, scarcely any change can be observed. That is to say, the nebulæ are either all moving directly towards or away from the earth, which is incredible, or, although they have a lateral motion of enormous rapidity, they are so far away that the distance traveled in fifteen years is imperceptible to us. How great their distances may be we can not comprehend, even though it were expressed in figures. From here to the utmost confines of our stellar system is estimated as being of the order of 15,000 light years, that is the distance light will travel, going at the rate of 186,400 miles per second, in 15,000 years. And if this theory be correct, the nebulæ are so far away that, though as large probably as our stellar system, they seem to us scarcely larger than one of the planets. We may therefore look upon them as other stellar systems like our own. And if there be on a planet within one of these spirals, astronomers and telescopes such as we have, to them our stellar system would appear as a spiral nebula, a scarcely visible point of light in the starry heavens.

Now Campbell would carry us one step further in our search for the true theory for the origin of the world. At a certain point within the great spiral, a subsidiary whirl was developed within which grew, by the infall of planetesimals, as suggested by Chamberlin, our solar system, including the infinitesimal speck of matter upon which we live our unquiet lives.

VI

I have now traced the growth of man's idea of the origin of the planet on which he lives from the crude cosmogony of primitive ages up to the scientific theories of the twentieth century. Notwithstanding periods of intellectual stagnation and even of retrogression, this represents a continuous broadening of his grasp upon the realities of his physical environment. But we have not yet attained finality. The great mysteries of knowledge are as yet unfathomed.

But one thing we have learned.

> The spirit of eternal change,
> Which is the soul of nature

is all pervading. What we see is but an evanescent phase in an endless series of changes. There was a time when they did not exist; there will come a day when the thousands of fiery suns which we see in the heavens to-night will, each one, have cooled down to darkness and death. To our finite minds the life of a sun, measured as it must be by hundreds of millions of years, seems inconceivably long, but to "the spectator of all time and all existence" to borrow Plato's noble expression, it is but as a momentary flash. Now although it is believed that there are a great many dark bodies in the heavens, most of the stars are still alight. Together they came into being, together their fires will disappear.

> They shall all grow old as doth a garment, and as a vesture shalt Thou fold them up.

William Harvey McNairn

WORK OF THE DEPARTMENT OF AGRICULTURE

Reviewing the progress of the campaigns for increased production to meet war demands and conditions, David F. Houston, Secretary of Agriculture, in his annual report states that the farmers of the nation, patriotically responding to the appeals of agricultural and other agenices, have produced more than 5¼ billion bushels of cereal food crops—exceeding by 1,000,000,000 bushels the five-year average for cereals—record crops of Irish potatoes and sweet potatoes, large crops of beans and sugar beets, and an unusually large crop of perishables. Authentic figures for meat, poultry, dairy products, and vegetable oils are not available for 1917, but rough estimates indicate that the quantity for the year is slightly greater than for either 1916 or 1915 and exceeds the five-year average by two or three billion pounds.

It must be borne in mind, however, the secretary says, that the 1917 cereal crops are 199 million bushels below the yield of 1915; that the carry-over of cereals from last year was much below the normal; that the percentage of soft corn of the 1917 crop—which can not be used for food—is unusually high; and that, with the destruction of live stock in Europe and the great demands from there for meats and fats, with consequent greatly increased exports from the country, the supply of meats and fats will not be adequate to meet the domestic needs and those of the nations with which we are cooperating.

"That the farmers of the nation have generously responded to the appeals for increased production, and that much has already been done to insure a large supply of foods and feedstuffs, justifies no let-down in their activities or in those of all agricultural agencies," the secretary says. "On the contrary, even greater efforts must be put forth in the coming months if we are to meet satisfactorily the domestic demands and the needs of the nations with which we are associated in this struggle. There must be no breakdown on the farms, no failure of foods, feedstuffs, or clothing. I can not emphasize too strongly the urgent necessity of doing everything possible to bring about a still further increase in the production of all essential commodities, particularly of the staple crops and live stock.

The yields in 1917 of the major food crops are as follows, the secretary reports, according to unrevised estimates: 3,191,000,000 bushels of corn, 659,797,000 of wheat, 1,580,000,000 of oats, 201,659,000 of barley, 56,000,000 of rye, 16,813,000 of buckwheat, 33,256,000 of rice, 73,380,000 of kafir, 439,686,000 of Irish potatoes, 84,727,000 of sweet potatoes, 15,957,000 of commercial beans, 42,606,000 of peaches, 11,419,000 of pears, 177,733,000 of apples, and 7,621,000 tons of sugar beets.

"The actual increase in the acreage of crops sown this fall can not be accurately determined at this time," the secretary says. "There is every indication, however, that the farmers in the sections where fall grains can be profitably raised have patriotically responded to the nation's call for more breadstuffs. Reports made to the Bureau of Crop Estimates in August, before the campaign for increased acreages was well under way, indicated an intention on the part of farmers to increase their sowing of winter wheat by about 10 per cent., and of rye by about 3 per cent. If these intentions are realized, it will result in the planting of 44,100,000 acres of wheat and about 4,340,000 acres of rye. Reports received since August are to the effect that the fall-sown acreage of these two crops has been increased in nearly every state, although the drought in the Southwestern States and in portions of Washington has made it impracticable fully to carry out the planting program. The official estimate of the acreage of winter wheat and rye will be issued on December 19 after the planting of winter grains is completed in the South. Similarly, it is too early to determine the percentage of germination of seed actually sown, and therefore any prophecy at this time as to the actual harvest of winter wheat to be expected in 1918 would be merely a guess."

The report outlines the efforts of the department of agriculture to increase the meat supply and sums up the live-stock situation as follows:

"The number of milch cows and other cattle has shown an increase during the last four or five years, the estimate for the former for the present year being 23,906,000, as againts 22,768,000 a year ago and 20,497,000 in 1913, before the European war began, while that for the cattle is 43,291,000, as against 40,849,000 a year ago and 36,030,000 in 1913. Unfortunately, the number of sheep continues to decline; the estimate for 1917 is only 46,059,000, as against 48,483,000 a year ago and 51,482,000 in 1913. It is estimated that the number of hogs, which during recent years has shown an upward tendency, decreased over 4,000,000, or from 67,453,000 to 62,747,000. However, it is greater than it was at the beginning of the European war. The number of hogs varies from year to year more widely than that of the larger meat animals. . . . The mere statement that the population has steadily increased in this country—the gain in the 10 years from 1908 to 1917 being 13,000,000—with an absolute decrease in the live stock for the same period, would sufficiently emphasize the seriousness of the situation if conditions were normal and the demands for meats and fats were not so urgent." There is a close relationship, the report says, between the production of live stock and the supply of feedstuffs, and the large production of these necessaries during the present season should conduce to more satisfactory conditions for the producers of live stock.

Nation-wide campaigns to increase the meat supply are in progress, the report shows. As hogs and poultry yield the quickest returns, urgent efforts are being made to increase their production. Funds have been set aside from the appropriation made by the food production act to employ a force of 32 additional specialists to give their time to the task of increasing the number of hogs, 30 to encourage poultry raising, and 6 to assist producers of cattle.

By the end of October field agents of the department had assisted in the transfer of 100,000 cattle from localities where there is a shortage of feed to areas where feedstuffs are relatively abundant. This work has resulted in the saving to the nation of large numbers of animals.

Every effort has been and is being made to protect crops and live stock from diseases and pests. The force of experts dealing with these matters has been greatly increased and they are maintaining constant vigil and asisting in combating outbreaks in their early stages. Forty additional expert entomologists will be placed in the field to cooperate with the extension forces, and specialists familiar with seed treatment for the prevention of smuts of wheat, barley, oats, and rye, which alone cause losses of from 50 to 60 million dollars a year, have been assigned to prevention work in Oregon, Ohio, New York, Tennessee, Indiana, Illinois, Oklahoma, Texas, Washington, and California.

Under the food production act, the facilities of the Bureau of Animal Industry for dealing with live-stock diseases have been further extended. Forty-six workers have been added to the force combating cattle ticks in the South. Fifty-one per cent. of the original infested territory has now been cleared of the tick. Hog cholera losses decreased 30 per cent. during the last year, and 65 additional veterinarians have been assigned to the work of controlling the disease. In 12 states an inspector has been detailed to assist in combating tuberculosis of cattle and swine and of abortion of cattle, and it is proposed to increase the number to 19. Other specialists are engaged in the work of controlling blackleg of cattle and anthrax of domestic animals.

Calling attention to the fact that the nation was facing an unsatisfactory situation with respect to its supply of foodstuffs and feedstuffs when the existence of a state of war was declared, the secretary outlines some of the efforts of the department and its cooperating agencies to increase the production of these commodities even before the entrance of the United States into the conflict. He then describes the steps taken to bring about more effective organization and closer coordination of the agricultural agencies of the nation, beginning with the conference with the official agricultural representatives of the various states, which was held at St. Louis, Mo., on April 9 and 10. States east of the Rocky Mountains were represented at the meeting and a similar conference for the states west of the Rockies was held at Berkeley, Cal., on April 13.

As an indication of the assistance which the bureaus of the department of agriculture have rendered and are rendering to the War and Navy Departments and to other branches of the government in connection with war problems, the annual report of the secretary of agriculture cites the following:

The Bureau of Animal Industry is cooperating in the reinspection of meats and meat food products at 27 naval stations and at various army camps, cantonments, forts, and other places. The dairy specialists of the department have investigated local situations and made suggestions to insure sanitary milk supplies for the army cantonments and naval stations and also have inspected large quantities of butter for the navy. Supplies of vegetables purchased and loaded on the naval supply ships are being inspected by representatives of the Bureau of Markets. The Office of Home Economics has studied the rationing question for the army, navy, and coast guard service. The Bureau of Chemistry has prepared specifications for army and navy foods and has analyzed products offered for inspection. This bureau also has assisted in standardization of army and navy food supplies and is conducting research investigations on the antiseptic qualities of some important compounds.

The Bureau of Entomology has placed its experts, as well as all information on camp sanitation in its possession, at the disposal of the Medical Corps. The Bureau of Soils has cooperated with the War Department in investigations relating to fixed nitrogen and sulphuric acid. Experts of the Office of Public Roads and Rural Engineering have been detailed to assist the War Department in road building at the 16 cantonments.

The Forest Service has given assistance to the War and Navy Departments and to other national agencies in locating new sources of wood and in seasoning the product, has assisted in the organization of a regiment of engineers for forestry work abroad, and is now cooperating with the War Department in the organization of a second regiment. The Weather Bureau, in addition to furnishing weather information to the army and navy, has assisted the War Department in the organization of its aerological observation work and of a regiment for gas and flame service.

SCIENTIFIC EVENTS

AMAZON EXHIBITS AT THE UNIVERSITY OF PENNSYLVANIA MUSEUM[1]

THERE is now on public exhibition at the University of Pennsylvania Museum a large share of the collections which Dr. Wm. C. Farabee made during his three years' explorations of the Amazon, from which he returned last year. It has taken him a year to go over and catalogue his collections carefully, to label them and to install them in the galleries on the first floor of the museum.

During his three years in South America Dr. Farabee made his headquarters at Para, at the mouth of the Amazon, from which all of his various trips into the interior were made. The first journey was a thousand miles up the Amazon to Manaos, thence almost directly north into the highlands which divide Brazil from the Guianas, thence several hundred miles westward until it was no longer possible to travel by water, from which point he started eastward overland through the southern portion of British Guiana, spending many months among the Carib and Arowak, most of whom had never before seen a white man.

It was here that Dr. Farabee did some of his most important scientific work, since here were grouped a number of entirely distinct tribes of Indians, all of whom are rapidly diminishing in population and some of which are on the verge of extinguishment. From this point, having sent his collection down the Amazon, he made the terrible journey across the divide and down the Corentyne, during which he lost most of his equipment, all of his food and medicine, was obliged to live on monkeys and alligator meat, when even those were available, suffered terribly from fevers and finally reached the coast more dead than alive. Thence he went to the island of Barbados, where he met Colonel Roosevelt just returning from his trip through Brazil.

Dr. Farabee's second tour was up to the head waters of the Amazon River into the lower hills of the Andes in eastern Peru. Unfortunately, about the time he reached this section news of the great European war had come up the river and utterly dislocated all of his arrangements, making it impossible to get money or bring up supplies, so that he was obliged to return to Para, but not until after he had made some highly interesting and important researches and had secured a great number of the finest specimens of Conebo pottery in existence, which he managed to bring down with him and which are now on exhibition.

Subsequent trips were up some of the southern affluents of the Amazon, marching across from one great river to another, and investigating country never before trodden by a white man. Another series of explorations were to the north of the Amazon, not many hundred miles from the coast, where he also found hitherto unknown tribes and where he made collections, especially of large pottery animals used for burial urns These were deep in the Amazon wood.

The results of all those journeyings are now on exhibition on the first floor of the museum. The room to the left is occupied with ancient and modern pottery and those whoever they were that made this pottery had a very much higher culture than any existing Indians in South America. It is doubtful if the Incas themselves at any time reached as fine a development in the making of pottery, but there is not the slightest clue as to who these people were, whence they came, when nor how they disappeared. None of the Indians who now occupy that portion of the country have even any myths about it, and this is the more remarkable because primitive races, as a rule, retain some shadowy recollection or myths of antecedent peoples for a great many centuries. Nowhere else in South America has there been the slightest trace discovered of a culture resembling this, or of several cultures, and it is very unfortunate that just now there does not seem to be any material at hand to solve the mystery. These colossal funeral jars are the most important features of this part of the exhibit. Some of them are large enough to admit two entire bodies seated side by side.

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[1] From *Old Penn.*

On the other side of the room in which this ancient pottery is shown Dr. Farabee has installed a great collection of several hundred pieces of the Conebo pottery. This is entirely modern and is the most striking pottery of the kind to be found anywhere in the world, and in fact only a few specimens of the smaller kind are to be found in any museum. About half a dozen of these jars are four feet high and about the same diameter, but resting on a very small base and having the general appearance of an inverted, truncated cone. They will hold several barrels each and are used by the natives to hold the beer, which they greatly enjoy.

THE CHEMICAL INDUSTRIES OF THE UNITED STATES

The annual report of Franklin K. Lane, Secretary of the Interior, gives the data on the growth of the chemical industries in the United States since 1914. Not only have factories sprung up to manufacture products formerly imported but great expansion has taken place to supply the increased demand for all chemical products. The country now manufactures practically everything required along chemical lines.

The increase in capital invested in chemical industries was, in 1915, $65,565,000; in 1916, $99,244,000; and up to September, 1917, $65,861,000 over the preceding year. New chemical industries are now being opened up at an unprecedented rate, owing to war needs and the energy of American chemists and physicists.

Before the war 90 per cent. of the artificial colors and dyes were imported, five or six concerns with 400 operatives producing 3,300 short tons per year. Now there are over 90 enterprises, each making special colors, and 100 concerns making crudes and intermediates.

Sulphuric acid, the chemical barometer, has doubled in production. In 1916, 6,250,000 tons of 50° Bé. were produced. The estimate for 1917 is much greater, and the production for 1918 will again greatly increase.

By-product coking doubled its capacity in the last three years, yet in 1918 the United States will make half her coke in beehive ovens. Light oil, which contains the benzene and toluene needed for explosives, jumped from 7,500,000 gallons in 1914 to 60,000,000 gallons in 1917, and is again being largely increased. Ammonia production has increased 100 per cent. in three years and the visible supply is insufficient to meet demands.

Gasoline production has increased from 35,000,000 to 70,000,000 barrels per annum since 1914.

Potash importation from Germany was stopped by the war, which has stimulated production in this country. The production from January to June, 1917, was 14,023 short tons of potash. This is a small production, but sodium salts have been substituted for almost all purposes except agriculture. Shortage of labor and coal is seriously interfering with the potash-brine evaporation in Nebraska, which was yielding about 90 tons per day.

The production of explosives and consequent consumption of nitric acid has increased enormously. The nitric acid is still almost entirely made from Chili saltpeter, but synthetic nitrogen plants are under process of construction, and we have large quantities of coal-tar ammonia which can be used for munitions if necessary.

Before the war 40,000 tons of barite were imported from Germany for the manufacture of lithopone. Now five companies are producing this article from deposits in Tennessee, Kentucky, Virginia, and Missouri.

The smelting of all metals, iron, zinc, copper, antimony, tin, mercury, etc., and their alloys has increased to meet the country's needs.

Domestic supplies of manganese and pyrite have been augmented.

These are but a few instances of our chemical progress. The matter can be summarized by saying that American chemists have met the country's needs as ably and completely as did the chemists of Germany. We can go forward with every confidence of no serious shortage of the many chemical products required for domestic consumption.

THE AMERICAN METRIC ASSOCIATION

The association will meet in Pittsburgh on December 28 and 29 under the presidency of Dr. George F. Kunz, of New York. The first two sessions are to be held in conjunction with the Section on Social and Economic Science of the American Association for the Advancement of Science. The program will be as follows:

FRIDAY, DECEMBER 28

2 P.M. Mr. George W. Perkins, of New York, and Mr. J. W. McEachren, of the Crane Company, Chicago, will present papers for discussion.

Friday evening will be free for the opening session and reception of the American Association for the Advancement of Science, with which the American Metric Association is affiliated.

SATURDAY, DECEMBER 29

10 A.M. The officers will render their annual reports. These will be followed by Dr. William C. Wells, chief statistician of the Pan-American Union; Mr. Henry D. Hubbard, of the United States Bureau of Standards, and others dealing with the general problem of international standards and their application to important industries in the United States and Canada.

2 P.M. Dr. John A. Brashear, past president of the American Society of Mechanical Engineers, will introduce the speakers who have prepared papers for the Standards Committee of the American Metric Association. Engineers and business men are especially requested to attend this session. Technical problems in connection with the general use of metric weights and measures will be given special attention at this time.

6.30 P.M. An informal "Metric Dinner" will be served at the Hotel Schenley. The charge will be two dollars per cover, and those who desire to attend are asked to leave their names at the hotel office.

8 P.M. The final session in the Hotel Schenley, at which time officers for the ensuing year will be elected, and necessary business disposed of. The present rapid metric progress and the best methods for final success will be discussed by leaders in the metric movement.

SCIENTIFIC NOTES AND NEWS

The secretary of agriculture has announced the appointment of Dr. John Robbins Mohler as chief of the Bureau of Animal Industry of the United States Department of Agriculture. Dr. Mohler succeeds the late Dr. Alonzo D. Melvin, who died on December 7. Dr. Mohler has been in the service of the Bureau of Animal Industry since 1897, and has been assistant chief of the bureau since July 1, 1914. During the long illness of Dr. Melvin, Dr. Mohler performed the duties of acting chief as well as those of chief pathologist.

A portrait of Professor Thomas C. Chamberlin, head of the department of geology and paleontology at the University of Chicago, has been presented to the university by graduates and former students of the department.

Dr. Lightner Witmer, professor of psychology in the University of Pennsylvania and director of the psychological laboratory and clinic, sailed last week for Europe. He expects to have the direction of social service work in a foreign country under a commissioner appointed by the War Council of the American Red Cross, and has been granted leave of absence by the university for the remaider of this year. During Dr. Witmer's absence, Dr. Edwin B. Twitmyer will be acting director of the psychological laboratory and clinic.

PROFESSOR ANTON JULIUS CARLSON, chairman of the department of physiology, at the University of Chicago, has been assigned to the Sanitary Corps of the United States Army and is expected soon to be in France.

ASSISTANT PROFESSOR FREDERICK E. BREITHUT, in charge of municipal chemistry in the department of chemistry in the College of the City of New York, has been appointed director of food conservation by the United States Government Food Commission, to cover the territory of Greater New York City.

DR. HUGO DIEMER, major in the ordnance department, U. S. R., is in charge of the Ordnance Inspection at Lowell, Mass., including accountability for all materials of United States property, production progress, shipping, and ballistic inspection.

ARTHUR H. NORTON, vice-president, and head of the department of mathematics of Elmira College, has been granted a leave of absence for the remainder of the year. He sailed for France on December 12 to take charge of a Young Mens' Christian Association base camp.

PROFESSOR ARTHUR W. BROWNE, of the department of chemistry of Cornell University, has been appointed chemical expert of the Ordnance Department. He will continue his work at Cornell University.

MR. RALPH MCBURNEY, instructor in the department of bacteriology of Oregon Agricultural College, has been commissioned as first lieutenant in the Sanitary Corps of the United States Army. According to orders he has reported at Letterman Hospital, San Francisco.

To Dr. Edwin F. Hirsch, of the department of pathology, of the University of Chicago, has been given leave of absence for service on the medical staff of the Officers' Reserve, United States Army.

DR. CHARLES W. STILES, of the United States Public Health Service, has been given jurisdiction over sanitary affairs in the zone about Camp Hancock, near Augusta, Ga., and will work in cooperation with the health forces already in operation there.

DR. GUSTAV F. RUEDIGER, for the last three and a half years director of the Hygienic Institute for LaSalle, Peru, and Oglesby, Illinois, has resigned that position to become director of the State Hygienic Laboratory of Nevada, University of Nevada, Reno.

PROFESSOR C. L. MCARTHUR, bacteriologist, University of Arkansas, has been appointed to be assistant bacteriologist in the department of bacteriology at Oregon Agricultural College.

THE council of the Institution of Civil Engineers of Great Britain has made the following awards for papers published in the proceedings without discussion during the session 1916–17: A Watt gold medal to Major H. S. B. Whitley (Neath); Telford premiums to W. C. Popplewell (Manchester), H. Carrington (Woodley, Stockport), Dr. A. A. Stoddard (Bournemouth), A. E. L. Chorlton (Lincoln), and B. M. Samuelson (Rangoon); the Manby premium to R. Bleazby (Perth, W.A.); the Webb prize to J. B. Ball (London), and the Howard Quinquennial prize to Dr. W. C. Unwin.

SECTION K of the American Association for the Advancement of Science has arranged for a symposium at Pittsburgh on the "Medical lessons of the war." Lieutenant George Loewy, of the French Army, is expected to give the principal paper.

THE third annual meeting of the Mathematical Association of America will be held at the University of Chicago on Thursday and Friday, December 27–28, 1917, in conjunction with the Chicago Section of the American Mathematical Society which meets on Friday and Saturday of the same week. The program reports of standing committees will be presented as follows:

1. Committee on Mathematical Requirements. "Scientific investigations of the committee," Professor A. R. Crathorne, University of Illinois. "The work of a committee representing the Central Association of Science and Mathematics Teachers," Mr. J. A. Foberg, Crane Junior College, Chicago.

2. Committee on Libraries. Discussion opened by Professor H. E. Slaught, University of Chicago.

3. Committee on Mathematical Dictionary. Preliminary report by the chairman, Professor E. R. Hedrick, University of Missouri.

At a meeting of the teachers of physics in Indiana colleges held at Bloomington, Indiana, on December 10, steps were taken toward an organization of the physics research work throughout the state. Dr. A. L. Foley, head of the physics department of the University of Indiana and chairman of the Scientific Research Committee of the State Council of Defense, was chosen as director of this movement. It is hoped that this organization will survive the war period and prove a valuable aid in developing research work in physical science in Indiana.

Professor George Sarton, lecturer on philosophy at Harvard University and editor of *Isis*, gave at the University of Chicago a public lecture, with illustrations, on December 7, his subject being "Science and civilization at the time of Leonardo da Vinci."

Dr. William Curtis Farabee, curator of the American section of the University of Pennsylvania Museum, lectured on "Exploration in the valley of the Amazon," before the Geographic Society of Chicago on December 14.

Richard Swan Lull, professor of vertebrate paleontology at Yale University, gave an illustrated lecture on the Luther Laflin Kellogg Foundation, under the auspices of the Phi Beta Kappa Society at Rutgers College, on December 7. His subject was "The pulse of life."

The governors of the West Ham Municipal Central Secondary School, London, plan to call the institution "The Lister School," to perpetuate the association of Lord Lister with the borough.

The death is announced at the age of fifty-seven years of Dr. Ramon Guitaras for many years professor of surgery in the New York Post Graduate Hospital.

William McKnight Ritter, the astronomer, formerly connected with the Nautical Almanac Office and there closely associated with the work of George W. Hill, died on November 6, at his home in Pottsgrove, Pa., at the age of seventy-one. In his earlier astronomical career he became, through Professor Watson, of Ann Arbor, greatly interested in the computation of orbits for minor planets, and during the later years he devoted special study to the problem of the general perturbations of these planets.

Dr. Ami Jacques Magnin, chief surgeon of the American hospital at Neuilly, died suddenly on November 25.

Dr. J. Peyrot, professor of surgery at the University of Paris and senator, has died at the age of seventy-four years.

F. C. Barraza, professor of organic chemistry at the University of Buenos Aires, has died, aged fifty-five years.

We learn from *Nature* that the death is announced, while leading his platoon during one of the recent advances in France, of Second Lieutenant F. Entwistle, second assistant at the Observatory, Cambridge, aged twenty-one years. Mr. Hartley, first assistant at the Cambridge Observatory, was killed on the *Vanguard* on July 9. The double tragedy exhausts the staff of the observatory, as distinct from the Solar Physics Observatory, except for the director.

In view of the many unusual conditions due to the war, it has been deemed inadvisable to hold a meeting of the Association of American Geographers this year, and the meeting planned for Chicago has been abandoned. Professor Robert DeC. Ward's presidential address, entitled "Meteorology and aviation: some practical suggestions," will be published in the near future. This, and other papers prepared for the meeting, will appear in the *Annals* for 1918.

After serious consideration and correspondence with all exhibitors, the managers of the Chemical Exposition have decided to abandon plans to hold a Chemical Exposition in Chicago in the Spring. This action was taken because of insufficient support secured to make a large and representative exposition, all the exhibitors wishing to confine their efforts toward making the Fourth National Exposition of Chemical Industries in New York, week of September 23, 1918, the greatest event in the history of American Chemical Industry.

The directors of the Fenger Memorial Fund announce that the sum of $500 has been set aside for medical investigation, the money to be used to pay a worker, the work to be done under direction in an established institution, which will furnish the necessary facilities and supplies free. It is desirable that the work should have a direct clinical bearing. Applications with full particulars should be addressed to Dr. L. Hektoen, 637 S. Wood St., Chicago, before January 15, 1918.

A national institute of malariology is about to be established in Italy; it will be a part of the department of agriculture. Its objects are to investigate the relations between malaria and agriculture; to study experimentally and otherwise the direct and indirect causes of the unhealthiness of malarial districts; and to organize and direct a campaign against those causes, and particularly against the *Anopheles*.

Mr. Hodge, British minister of pensions, received on September 17, a private deputation from the Roehampton Hospital Committee regarding the proposal to establish a national experimental laboratory for the purpose of designing and controlling the manufacture of artificial limbs for disabled soldiers. By experiments, and by making full use of the experience of men who had been fitted with artificial limbs, it was hoped, the deputation suggested, to improve greatly the types of limbs supplied at present. Mr. Hodge declared his intention of taking immediate steps to seek the necessary funds for the establishment of a National Experimental Laboratory which might ultimately become a national factory for manufacturing limbs. For the present, however, he was opposed to the establishment of a national factory. It was, in his view, essential that the committee of management of the National Laboratory should be small, representative of surgeons and mechanical experts, and distinct from any committee managing hospitals for limbless men. The laboratory committee would be directly responsible to the Ministry of Pensions, and would be empowered to ensure that the improvements which they recommended should at once be introduced into the manufacture of artificial limbs.

It was proposed to submit a plan for establishing a central organization of engineers and educationists to a conference of engineers from all parts of the country which was held at the British Institution of Civil Engineers on October 25. Sir Maurice Fitzmaurice, president of the institution, presided and the honorary organizers of the movement are Mr. A. P. M. Fleming (British Westinghouse Company, Trafford Park, Manchester) and Mr. A. E. Berriman (chief engineer, Daimler Company, Coventry). The plan suggested, which includes the reinstatement of the best ideals of the old system of apprenticeship, provides for the setting up by engineering firms of a central bureau for the better coordination of engineering training and the appointment of a representative committee of engineering and educational interests to initiate action.

UNIVERSITY AND EDUCATIONAL NEWS

A general Science Hall, erected at a cost of $60,000, is under construction at Defiance College, Defiance, Ohio. It will be a three story building and is expected to be completed by next July.

The Provost Marshal General has sent the following telegram to the governors of all states:

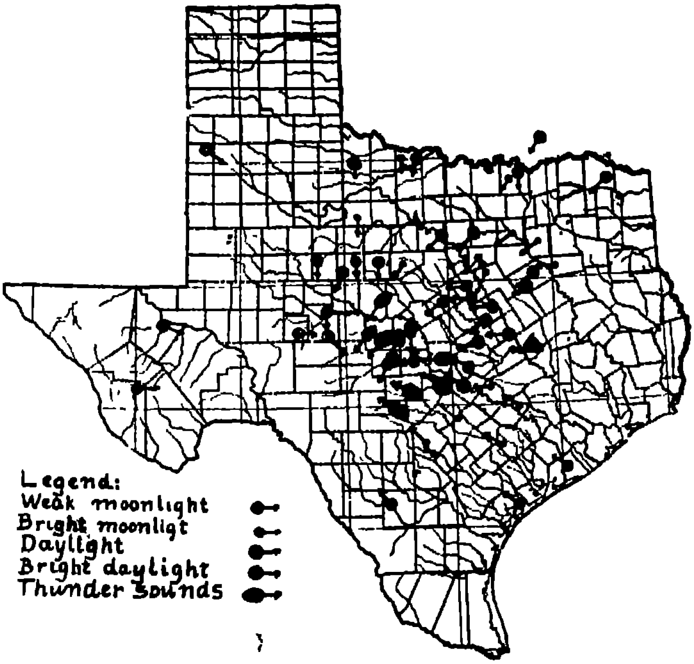
> Under such regulations as the Chief of Engineers may prescribe a proportion of the students, as named by the school faculty, pursuing an engineering course in one of the approved technical engineering schools listed in the War Department, may enlist in the Enlisted Reserve Corps of the Engineer Department and thereafter, upon presentation by the registrant to his local board of a certificate of enlistment, such certificate shall be filed with the Questionnaire and the registrant shall be placed in Class 5 on the ground that he is in the military service of the United States.

Dr. Charles T. P. Fennel, for fifteen years state chemist in Ohio, and later professor of chemistry in the Cincinnati College of Pharmacy, has been appointed to the chair of materia medica at the University of Cincinnati to fill the vacancy created by the death of Dr. Julius Eichberg.

DISCUSSION AND CORRESPONDENCE

A TEXAS METEOR

On October 1, at about 10:30 p. m., an unusually bright meteor appeared over the central part of Texas. The undersigned promptly made arrangements to secure information on its appearance throughout the state, while the phenomenon was yet fresh in the memories of those who saw it. Notes from some threescore observers have been secured. From these it appears that the place where this aerolite fell must be somewhere in or near Kimble County. The observed directions all converge toward this county. Evidently the path this meteor followed was at a considerable angle to the horizon and had a course from northeast to southwest. Nearly all observers agree that at first the light of this meteor was small. Increasing rapidly in brilliancy, it terminated abruptly with an explosion at some considerable distance above the ground. To the most distant observers it appeared to reach the horizon. Over an area of some 150 miles in diameter, north of Bandera County, sounds like that of thunder were heard from three to five minutes after the meteor disappeared. At Brady and at one or two other places, these sounds are reported to have been strong enough to shake buildings and to cause dishes and windows to rattle. The light in the same region is likened to strong lightning and it is said to have been blinding to some observers. The usual thin cloud of dust high in the sky was noted by several parties, who say it could be distinctly seen for 40 minutes after the fall.



The meteor was observed over the entire state, from the Gulf to the Panhandle and from the northeast counties to the far mountains west of the Pecos, a distance of nearly six hundred miles. Several parties who saw the bright body at a distance of about 200 miles or less, report hearing a swishing or buzzing sound, which seems to have been simultaneous with the appearance of the light. This communication is prompted chiefly by a desire to learn if such sounds have been previously reported as being connected with meteoric falls. Several circumstances in the present case indicate that this sound was real, and not psychological. May it have been the indirect result of some form of electric energy? One observer seems to refer this sound to objects attached to the ground.

J. A. Udden

Austin, Texas,
October 22, 1917

ON THE COLLOID CHEMISTRY OF FEHLING'S TEST

To the Editor of Science: Fischer and Hooker make the following statement in their article "On the Colloid Chemistry of Fehling's Test," page 507, Science:

> Formaldehyde reduces Fehling's solution not only to the ordinary cuprous oxide, but to the metallic copper. The copper comes down in colloid form, but as this happens, a second reaction ensues in which the metallic copper acts upon the formaldehyde and decomposes it with the liberation of hydrogen. The liberation of hydrogen continues for hours, until either all the formaldehyde has been decomposed or all the copper salt has been reduced.

In a study on the preparation of colloidal gold solutions by Dr. J. H. Black and myself (which is being reported by Dr. Black at the present meeting of the A. M. A. at New York), question arose regarding the probable explanation of the mechanism by which neutral sols are obtained although distinctly alkaline (to alizarine) sols should result from the proportions of reagents employed. I suggested the hypothesis that the colloidal gold acted as a catalytic agent to oxidize the free formaldehyde to formic acid, which latter reacted with the potassium carbonate responsible for the alkalinity.

It occurs to me therefore that it would be better to picture the colloidal copper functioning as a catalytic agent which oxidizes the HCHO in part, the remaining part serving to reduce the copper salt. The idea advanced by them that colloidal copper is produced is certainly reasonable; it is very difficult to understand how formaldehyde would liberate hydrogen.

Louis Rosenberg

Department of Chemistry,
Baylor Medical College

SCIENTIFIC BOOKS

The Fundamentals of Botany. By C. S. Gager. Philadelphia, P. Blakiston's Sons & Co.

We are fortunate in the United States in having a number of excellent elementary botanical text-books, written from different points of view. Professor Coulter has furnished an admirable beginners' book conceived from the standpoint of the head of a botanical department in a large university, who is at the same time an educational expert. From the hands of Mr. Bergen, whose recent demise we all deplore, we have had a succession of well-approved texts, written by one thoroughly in touch with instruction in the secondary schools. Professor Ganong has put forward from time to time books which reflect the outlook of the teacher in college work. The present volume comes from one who is the director of one of the most important botanic gardens in the country and who has, at the same time, made it his business to get into touch with his community, primary and secondary schools as well as the general public, in the closest possible manner. There can be little doubt, particularly at the present juncture, when the general public under the spur of patriotism and necessity, has largely abandoned its usual attitude of indifference toward plants, that Dr. Gager's book will prove extremely useful.

The relation of the author to his subject is admirable, as is shown by the following citation (p. 192).

> . . . In fact, we may say that our ignorance of life-processes greatly exceeds our knowledge. Very much more remains to be ascertained than has already been found out; for example, what is protoplasm? Nobody really knows. We have analyzed the substance chemically, we have carefully examined and tried (but without complete

> success) to describe its structure. We know it is more than merely a chemical compound. It is a historical substance. A watch, as such, is not. The metal and parts of which a watch is made, have, it is true, a past history; but the watch comes from the hands of its maker *de novo*, without any past history *as a watch*. But not so the plant cell. It has an ancestry *as a cell;* its protoplasm has what we may call a physiological memory of the past. It is what it is, not merely because of its present condition, but because its ancestral cells have had certain experiences. We can never understand a plant protoplast merely by studying it; we must know something of its genealogy and its past history.

It will be noted that although a physiologist in outlook, he has properly emphasized the historical and structural point of view so often and so deplorably neglected by the cultivators of disembodied plant physiology. The author obviously considers that living matter is to be studied *in vita* rather than *in vitro* (whether in glass models or merely in chemical glassware). By his broad outlook he has avoided the narrows which lead, on the one hand, into the ancient Scylla of systematic botany, or, on the other, into the more modern Charybdis of plant physiology.

The book is admirably printed on thin paper, so that its more than six hundred pages and well over four hundred illustrations make a conveniently thin and flexible volume, which is rendered still more useful by soft covers and rounded corners. The illustrations, whether original or borrowed, are for the most part good, and in some instances are of striking excellence. An adequate amount of space is given to the important themes of genetics and evolution, while the historical side is not neglected. Dr. Gager's work should be in the hands of every teacher of botanical science, and by its broadness and balance is admirably adapted for use in schools where the one-sided teaching of the facts of botany is by necessity and common sense excluded. The general text is accompanied by a laboratory guide, which is ingeniously contrived to avoid repetition and equally emphasizes structure and function.

E. C. Jeffrey

SPECIAL ARTICLES

WHY CHLOROFORM IS A MORE POWERFUL AND DANGEROUS ANESTHETIC THAN ETHER

Any one accustomed to administering anesthetics has observed that the amount of chloroform necessary to produce deep narcosis is less than that of ether; also that the period between slight and deep anesthesia is shorter and the lethal dose smaller with chloroform than with ether. These differences in the effects of ether and chloroform led Hewitt to state in his book on "Anesthetics" that chloroform is seven or eight times more powerful as an anesthetic than ether. In chloroform poisoning it is known that many of the organs, particularly the liver, are very seriously injured, while it is more difficult, or impossible in many instances, to produce such injuries with ether.

It is now recognized that in both chloroform and ether anesthesia oxidation is decreased or rendered defective, as is indicated by the decreased oxygen intake and carbon dioxide output and the appearance of certain incompletely oxidized substances such as β-oxybutyric and diacetic acids, and acetone. The decreased oxidation in anesthesia with resulting acidosis is much more likely to occur and to a much greater extent with chloroform than with ether.

Using practically all the means by which it is known that oxidation can be increased in an animal, as, for example, by food, by increasing the amount of work, by fight, or by thyroid feeding, we have found that there is always an accompanying increase in catalase, an enzyme in the tissues which possesses the property of liberating oxygen from hydrogen peroxide. We have also decreased, or rendered defective, the oxidative processes in animals, as, for example, by decreasing the amount of work, by starvation, by phosphorus poisoning, or by extirpation of the pancreas, thus producing diabetes, and have found that there is always a corresponding decrease in catalase. From these results it was concluded that it is probable that catalase is the enzyme in the body principally responsible for oxidation.

The object of the present investigation was to determine if catalase is decreased more quickly and more extensively during chloroform anesthesia than during ether anesthesia parallel with the greater decrease in oxidation and the quicker and more powerful action of chloroform. Cats were used in the experiments. The anesthetics were administered by bubbling air through ether or chloroform in a bottle which was connected by a rubber tube to a cone adjusted to the snout of the animal. The catalase content of the blood, taken from the external jugular vein, was determined before the administration of the anesthetic and at intervals of 15 minutes during the administration. The determinations were made by adding 0.5 c.c. of blood to 250 c.c. of hydrogen peroxide in a bottle at 22° C. and as the oxygen gas was liberated it was conducted through a rubber tube to an inverted graduated cylinder previously filled with water. After the volume of gas thus collected in ten minutes had been reduced to standard atmospheric pressure, after resulting volume was taken as a measure of the amount of catalase in the 0.5 c.c. of blood. The bottles were shaken in a shaking machine during the determinations at a rate of about 180 double shakes per minute.

The average amount of oxygen liberated by the blood of three cats previous to the administration of ether was 812 c.c.; that liberated after the animals had been under ether for 15 minutes was 740 cc.; that after 30 minutes of ether anesthesia, 630 cc.; that after 45 minutes, 475 cc.; that after 60 minutes, 480 cc.; after 75 minutes, 400 cc.; and that after 90 minutes, 380 cc. It will be seen that the catalase of the blood was gradually decreased during the 90 minutes of ether anesthesia, as is indicated by the gradual decrease in the amount of oxygen liberated, and that at the end of 90 minutes the catalase had been decreased by about 54 per cent., as is indicated by the decrease in the amount of oxygen liberated from 812 cc. to 380 cc.

Similarly determinations were made of the catalase of the blood of cats previous to chloroform anesthesia and at intervals of 15 minutes during the anesthesia. The average amount of oxygen liberated by the blood of three cats previous to the administration of chloroform was 900 c.c; that liberated after the animals had been under chloroform anesthesia for 15 minutes was 525 c.c.; that after 30 minutes, 325 c.c.; that after 45 minutes, 334 c.c.; that after 60 minutes, 320 c.c.; after 75 minutes, 330 c.c.; and that after 90 minutes, 310 c.c. It will be seen that the chloroform produces a very abrupt decrease in the catalase of the blood during the first fifteen minutes of the administration as is indicated by the decrease in the amount of oxygen liberated from 900 to 525 c.c., and that at the end of 90 minutes the catalase had been decreased by about 65 per cent., as is indicated by the decrease in the amount of oxygen liberated from 900 to 310 c.c.

By comparing the decrease in the catalase produced by ether and by chloroform it will be seen that the ether produced a gradual decrease as is indicated by the gradual decrease in the amount of oxygen liberated by 0.5 c.c. of the different samples of blood from hydrogen peroxide, whereas chloroform produced a very abrupt decrease during the first fifteen minutes of narcosis as is indicated by the great decrease in the amount of oxygen liberated from 900 to 325 c. c.

We have shown that small amounts of chloroform or ether added to blood in vitro destroy the catalase of the blood very rapidly. We have also shown that the liver is the organ in which catalase is formed, given off to the blood carried to the tissues.

The explanation that suggests itself for the decrease in the catalase of the blood produced during chloroform and ether anesthesia is the direct destruction of the catalase of the blood by the anesthetic and the decrease output of the catalase from the liver brought about by injury of the liver by the anesthetic. The more powerful and dangerous effect of chloroform as an anesthetic is attributed to the fact that chloroform is more potent than ether in producing a decrease in catalase, both by direct destruction of the catalase of the blood and by injuring the liver, thus decreasing the output of catalase from this organ with resulting decrease in oxidation. In fact it is probable that the cause of anesthesia is to be found in the decrease in the oxidative processes particularly of the nervous system produced presumably by the destruction of the catalase by the anesthetic. The specific action of anesthetics on the nervous system, according to this hypothesis, is due to the greater solubility of the lipoids or fat-like substances of nervous tissue which facilitates the entrance of the narcotic into the nerve cell and thus exposes the contained catalase more directly to the destructive action of the drug.

W. E. Burge

Physiological Laboratory of the
University of Illinois

THE AMERICAN ASSOCIATION OF VARIABLE STAR OBSERVERS

The formal organization meeting of the American Association of Variable Star Observers was held at the Harvard College Observatory, Cambridge, Mass., on November 10th and was attended by 25 or more members, almost all of whom are active participants in the observation of variable stars. The meeting was called to order by Wm. Tyler Olcott, who for the past six years has acted as secretary of the informal association, and A. B. Burbeck was appointed temporary chairman. A carefully drawn up constitution was read and accepted and then the officers and council members of the association were duly elected. D. B. Pickering, of East Orange, N. J., was elected president; H. C. Bancroft, Jr., of West Collingswood, N. J., vice-president; W. T. Olcott, of Norwich, Conn., secretary, and A. B. Burbeck, of North Abington, Mass., treasurer. The four members of the council are Professor Anne S. Young, of Mt. Holyoke College Observatory, J. J. Crane, of Sandwich, Mass., for two years, and Miss H. M. Swartz, of South Norwalk, Conn., and C. Y. McAteer, of Pittsburgh, Pa., for one year.

While waiting for the result of the election to be announced by the tellers, a general discussion of the most suitable size of telescope for the use of the observers was opened up, and later, a discussion of plans for the most systematic observation of the 300 or more variable stars under research was also freely indulged in.

In taking the chair as the first president of the association, Mr. Pickering reviewed, in a few words, the past achievements of the Variable Star Observers, and mentioned their aims for the future.

Tea was kindly served by the director of the observatory in the afternoon, and then lantern slide exhibits were given, one by Miss A. J. Cannon, showing some of the celestial wonders as revealed in the photographic telescopes, and another by Mr. Leon Campbell, illustrating the progress of the study of the star SS Cygni and what attempts are being made to fathom its seemingly irregular variations, both in light and period.

While an inspection of the work of the observatory was being made, the more experienced members observed this same SS Cygni in the comfortable 12-inch Polar Telescope, all under like conditions, and the result of the estimates of the 17 observers was that the star was then of the magnitude 11.21, with a probable error of 0.12 magnitude.

At a short meeting of the council, three noted variable star observers were elected to honorary membership, Professor E. C. Pickering, director of the Harvard Observatory; Rev. J. G. Hagen, director of the Vatican Observatory, Rome, and Professor J. A. Parkhurst, of the Yerkes Observatory. Professor Pickering was also elected as the first patron of the association.

The council also elected nine members to life membership and the total membership therefore numbers 84, of which 72 are active; 9, life, and 3 are honorary members, with 1 patron.

A sumptuous banquet was served in Boston that evening at which 20 members and four guests were present. Interesting after dinner speeches were made by Professors Pickering and Bailey, and Miss Cannon and Mr. Olcott, Mr. Campbell acting as toastmaster.

The meeting was considered the climax of all those yet held and marks the successful launching of a full-fledged association in America for the regular observation of variable stars by a group of amateur and professional astronomers, which has been doing excellent work along this line for some years past, and which bids fair to be even more useful to science in the near future.

Several committees were appointed by the president to consider the matter of telescopes, charts and schemes of work, and it was voted by the council to hold the spring meeting at East Orange, N. J., on May 6, 1918, at the invitation of President Pickering.

For those members who remained in Boston until the next day, an excursion was arranged to visit the Blue Hill Meteorological Observatory, where Professor McAdie was most attentive and explained in detail the investigations he is carrying on there.

The opportunity for interested parties to enroll themselves as charter members remains open until December 31, 1917, and all such persons are invited to join the association, to whom copies of the constitution will be sent upon application to the secretary, Wm. Tyler Olcott, 62 Church Street, Norwich, Conn.

L. C.

BOSTON MEETING OF THE AMERICAN CHEMICAL SOCIETY. IV

DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

H. P. Talbot, *Chairman*

E. B. Millard, *Secretary*

Joint Meeting with Division of Organic Chemistry, Wednesday Morning

1. *Two new laboratory instruments:* Arthur John Hopkins.

(*a*) A buret-micrometer.

A reading device which permits of correct readings to .001 c.c.

(*b*) A balance for first-year students.

A three-arm balance with non-removable riders in a glass and aluminum case. A distinctive arrest. The bearings are of stellite and the arms of invar tape. The ratio of the arms is such that the weight used is to the load as 4: 1.

2. *Water-lag in a buret:* Arthur John Hopkins.

A study of the amount of pure water clinging to the sides of a buret, under different speeds of discharge. The rule is deduced that, in order that comparable readings may be obtained, the discharge should not be faster than 12 to 15 seconds per cubic centimeter.

Limits of individuality in chemistry: N. T. Bacon. The chances for variation become less and less as complexity of structure is reduced, but now that we recognize atoms as being composed of many parts is it not proper to recognize that at least the individual molecule, if not the atom itself, may have an individuality? Probably each atom would have a normal arrangement of the multiplicity of parts going to build up the atom, but the question is raised whether it is not probable that owing to imperfect elasticity these frequently stand out of the normal position with reference to each other and reducing their tendency to combine so that frequently many times as many collisions are necessary before completion of combination as would be called for by theory.

A new hydrate of lime: H. W. Charlton. This hydrate of lime possesses marked plasticity, and differs from the ordinary $CaO \cdot H_2O$ in containing a considerably less amount of water. Its method of formation precludes the possibility of its being a mixture of CaO and $CaO\ H_2O$. One example of its formation comprises digesting $CaO \cdot H_2O$ with ten times its weight of water at 225 pounds pressure for a couple of hours. The resulting plastic material contains but slightly more than 15 per cent. water of combination while it originally contained over 24 per cent. and its specific gravity is but 1.95, while that of $CaO \cdot H_2O$ is about 2.078. This is remarkable as it would naturally be supposed that the specific gravity would lie some place between that of CaO -3.25 and that of CaO -2.078.

An investigation of the reaction between antimony and the solutions of sodium in liquid ammonia. Edward B. Peck. Solutions of sodium in liquid ammonia of concentrations from 0.0049 to 1.2482 gm. atoms of sodium per liter of liquid ammonia were sealed in glass bombs with an excess of antimony and allowed to react at room temperature for from two months to a year. A dark-brown, slightly soluble compound first formed, after which a dark-red solution appeared and the precipitate dissolved. The ratio of antimony to sodium in the solution does not correspond to a small integral number and changed with the concentration of sodium. The ratio Sb/Na changed very rapidly in dilute solutions from a value of $Sb/Na = 1.98$ to a maximum of $Sb/Na = 2.333$ at a sodium concentration of about 0.4N, after which there was a slight decrease to a value of $Sb/Na = 2.254$ at a concentration of 1.248 Two plots of the results were shown, one the ratio Sb/Na against the concentration of sodium, and another the log. of the sodium concentration against the ratio Sb/Na. In both these plots the results lay on a smooth curve. The apparatus for carrying out this work was described in detail. Weighed amounts of sodium were put up in small glass capsules. These capsules were placed across a tube provided with an electromagnetic hammer in the inside, which could be actuated by a solenoid outside. The reaction tube containing metallic antimony was sealed on to this tube. The tube was also connected to a supply of pure ammonia and to a vacuum pump. After evacuating the apparatus, ammonia was condensed in the reaction tube by surrounding it with a bath of liquid ammonia. The sodium was then introduced into the solution by breaking the capsule in two with the electro-magnetic hammer. As soon as the reaction was well started, the bomb was sealed off and allowed to react at room temperature. The bomb consisted of two compartments. When the reaction was completed, the solution was poured off from the excess antimony, and the antimony washed by distilling the solvent over from the solution. The analysis was completed by distilling off the solvent into weighed water bottles and weighing the antimony left behind. Electrolyses of these solutions were carried out at the temperature of boiling ammonia. The electrolyses showed that the compounds in solution are electrolytic in nature and that more than one atom of antimony is associated with each negative carrier. Both the analyses and electrolyses showed that there are at least two compounds involved in the final equilibria, one having more than two atoms and one having less than two atoms of antimony for each negative charge. These compounds are in some ways similar to the polyiodides. A detailed exposition of this investigation will be offered for publication to the *Journal of the American Chemical Society.*

The effect of acid concentration on the photochemical oxidation of quinine by chromic acid: G. S. Forbes and R. S. Dean. In a previous investigation of this reaction by Luther and Forbes, the acid concentration had been constant. In the dark, with concentrations of CrO_3 and purified quinine constant, the velocity varies as the square of the acid concentration. A shallow cylindrical dish was bisected by a glass partition, and revolved under a quartz mercury lamp. Provisions were made for stirring, cooling and temperature measurement. Solutions as described above were compared in pairs. After correction had been made for the dark reaction, the velocity of the photochemical reaction was found independent of acid concentration. It was also proved that quinine solution exposed to light does not retain its activation for long in the dark.

The temperature coefficient of the distribution ratio: G. S. Forbes and A. S. Coolidge. Solubilities in two and three component systems involving water, ether and succinic acid were determined or redetermined at 15°, 20° and 25°, also the distribution ratio of the succinic acid between two ether-water phases. An equation was derived and verified showing the temperature coefficient of the distribution ratio, with excess of the acid, as a function of the temperature and mutual solubility coefficients of each substance in each layer. The distribution ratio, when calculated on the basis of ether-water phases in which the ratios ether to water are constant, is by no means independent of the concentration of succinic acid. Evidence was secured that the average degree of association of water dissolved in ether at these temperatures is somewhat less than two.

The application of palladium as an indicator for silver titrations: L. Schneider. A very dilute solution of palladous nitrate, dissolved in an excess of nitric acid, is added to the silver nitrate solution which is then titrated with potassium iodide. The silver nitrate is precipitated by the potassium iodide and the least excess of potassium iodide is converted by the palladous nitrate to palladous iodide which is visible to the extent of one part in a million. For very dilute solutions, this method gives better precision than the Volhard method. The size of the plus and minus errors have been determined. The constant plus error in concentrated solutions is due to the palladous iodide being carried down by the silver iodide at the end-point, whereas the negative error is caused by the absorption of silver nitrate by silver iodide. The standard method for overcoming these errors has been applied with such effect that not only good precision but satisfactory accuracy has been obtained. The ease and rapidity with which the standard solution and the indicator can be prepared recommend this new method. Also the palladous nitrate method can be used to better advantage than Volhard's in cases where the silver nitrate solutions are colored pink or yellow. Nitrous acid interferes and must be boiled off before titrating.

The application of the thermodynamic methods of Gibbs to equilibria in the ternary system H_2O-K_2SiO_3-SiO_2*:* George W. Morey and Erskine D. Williamson. A discussion of Gibbs's derivation of the phase rule and the application of Gibbs's thermodynamic methods to various types of heterogeneous equilibria occurring in the ternary system H_2O-K_2SiO_3-SiO_2. The slopes of the various P-T curves which proceed from a quintuple point are discussed, with special reference to the dependence of the slope of a given curve on the composition of the phases which coexist along it. The change in slope with change in composition of phases of variable composition is discussed in detail. Conclusions reached in the above discussions are applied to typical cases in the ternary system H_2O-K_2SiO_3-SiO_2.

(To be continued)

SCIENCE

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THE MODERN SYSTEMATIST[1]

We are still engaged in exploring the earth, that we may understand it. We can not understand any part of the surface of the earth until at least three persons have studied the area carefully: the geologist, the physiographer, the recording biologist. We shall never cease to explore the earth, in old places as well as new. We can never dispense with the recorders.

The older systematic zoology and systematic botany fell into disrepute with the competition of the exacter studies in morphology and physiology, and they have been overshadowed by the interest centering in evolution and its derivative subjects. On the botanical side, the naming of specimens as an exercise in education in schools and the making of a so-called herbarium of snips of plants, have still further discredited whatever seems to be related to systematic work.

Although it is not the purpose of this paper to discuss the educational aspects of the subject, it may nevertheless be said that, so far as one can determine, this school herbarium work did not make botanists, on the one hand, nor lead to an appreciation of nature, on the other, and it would be difficult to trace contributions to science from its suggestion. As an educational method it was faulty because it did not connect plants with either function or environment, nor call for continued application on the part of the pupil. The intensive laboratory course that succeeded it developed exacter methods, more sustained application, closer scrutiny or observation and related the exercises to function. It has failed, however, in not educating in terms of the vegetable kingdom. We now see that the best educational procedure for botany in schools is a good combination of intensive laboratory work indoors, with carefully planned field and systematic work. The field naturalist contributes the factor of leadership in addition to drill with subject-matter; under his care, the environment of both men and other organisms begins to express itself. This, of course, is as true in zoology as in botany; in fact, good field work is both zoology and botany. This kind of field and collecting work provides the best approach to nature. To know a cell or a spore is of much less significance to the major part of mankind than to know a plant.

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[1] Before National Academy of Sciences, Philadelphia, November 20, 1917.

Some of the disdain of descriptive and taxonomic effort is due to the feeling, which is not without justification, that much of the so-called systematic work is little more than the personal naming and re-naming of specimens, without the addition of new knowledge or the expression of new meanings; the work is therefore likely to be disregarded, as irrelevant and not worth the while.

The systematist has also lost sympathy with many of his compeers because of the controversies over nomenclature. The impression has gone abroad that he deals only with names. The controversies in this field issue from two mistaken premises on the part of nomenclatorialists—the assumption that nomenclature can be codified into invariable law, and the practise of making rules retroactive. Varying practises in language tend in these days toward agreement and unification, the persisting variations being mostly in minor matters; as soon, however, as any superimposed authority undertakes to enforce rigidity, rebellion is invited and differences are likely to be organized into counter codifications. It is probably not even desirable to have rigidity in binomial nomenclature for plants. The reactionary nature of the rules is their greatest fault, however, and is responsible for most of the mischief. It upsets good practise, on which the literature rests, even as far back as Linnæus. Acts of legislatures, regulations of government, ordinances, entrance requirements to colleges and other enactments, become operative at a specified future date. The names of plants are vested rights to the users of them in literature, and there is no moral warrant for changing those of times past merely that they may conform to a rule of the present. If the practise were in the realm of enacted law involving property, any court would declare it illegal. I introduce this discussion to say that the changes in nomenclature are not a necessary part of systematic work except in so far as they result from changed biological conceptions of genera and species.

THE WORK OF THE SYSTEMATIST

With this preface, I may enter my subject, which is the place of the systematist in present-day natural history. I shall naturally speak in terms of plants, but I trust that some of you will make the extension to terms of animals.

To know the forms of life is the primary concern of the biologist. This knowledge is the basis of all study in morphology, physiology, heredity and phylogeny. Undoubtedly much of the looseness of statement and incorrect inference in writings on variation and heredity are due to the very inexact definition of the forms about which we talk. Much of the *non sequitur* lies here. Literature is undoubtedly full of examples. Every discouragement of the systematist reacts on the conclusions of those who cite the names of plants.

So fundamental is this contribution of the systematist that we should now be very cautious in talking of heredity in plants at all until we have redefined their forms. The records of variation, as such, do not constitute definitions, but only departures from assumed norms.

The definitions of the systematist, who critically surveys a wide range of material for comparison rather than for divergence, apply not only to the assemblages we know as species, but also to the minor forms that seem to have descriptive unity. If I were now working with any group of plants in an experimental way touching development and evolution, I should want first to turn the whole group over to a conservative systematist for careful review.

I had hoped that, in the beginning of the plant-breeding studies, the breeder would also be a pronounced systematist that he would aid us in the definition of the forms of plants, and bring his experimental studies to bear in tracing the probable course of evolution up to this epoch, that is, that he would contribute more freely to the knowledge of origins. I still think that we shall find the experimenter relating his work more closely to systematic botany as soon as the systematist takes cognizance of the plant-breeder, and the plant-breeder is satisfied that he must analyze his measurements in terms of biological definition and classification. I doubt the adequacy of some of the biometrical computation, and I regret the frequent neglect of herbarium studies whereby vegetation-factors rather than measurement-factors may be strongly emphasized.

It is not unlikely that the ecologist falls into false comparisons by carelessness in identification, or by inattention to critical differentiations. It really matters very much whether a given distribution represents one specific type, or two or more very closely related types; in fact, the significance of an ecological study may depend directly on allied taxonomic relationships.

Certain phases of the intermediate field between taxonomy and genetics I discussed two years and more ago in this city before the American Philosophical Society, and suggested a definite program of combined systematic and experimental work; therefore I shall not enlarge on this subject here, although it merits further attention. It may be noted in passing, however, that the more enthusiastic definition of forms demands a refined and more exact art of phytography, and it should lead also in the direction of classification. The marked variations may well find place in a taxonomic treatment rather than to be studied merely as separates. The remarkable mutations of *Nephrolepis*, for example, afford excellent material for systematic descriptive study.

Much of the earth is yet to be explored for the forms of life. There are fertile regions yet untouched. One collection in Papua yielded some 1,100 new orchids. Remarkable collections of novelties continue to come to our herbaria, many of them from regions not very remote. Not nearly all the plants of the globe are known. The systematist must continually be better trained, for he has the task of understanding the older accumulations as well as adjudging the new. He makes increasing contributions to plant geography and distribution, and gives us an enlarged judgment on the character of the countries of the earth as indicated by their vegetation. In fact, we never understand a country before we know its plant life. The contributions made recently by Forrest, Wilson, Purdom and others to the geography and resources of western China are good examples.

Yet it is in the old regions as well as in the new that novelties still come to the hand of the systematist. Every edition of the manuals of the plants of the northeastern United States, for example, contains large additions. These acquisitions are in some part the result of new introductions, running wild; in an important part the discovery of species heretofore overlooked; in large part, also, the results of redefinition, known as "splitting" of species.

This splitting is not alone the result of a desire to "make new species," but is the operation of a new psychology. In everything we are rapidly becoming particularists. In the time of Gray we studied plants as aggregates, trying to make them match something else; now we study them as segregates, trying to make them differ from everything else. This diversity in process accounts for the extension of *Œnothera, Carex, Rubus, Malus, Cratægus.* Whatever may be said of the relative ranks of the newly described species in a scheme of coordination, we should thereby nevertheless understand the forms better than heretofore and refine both our discrimination and our definition. Probably we do not yet really understand any one of the more representative genera of plants of the northeastern United States.

In making these remarks I am not commending the practise of those who would divide and redivide minutely, and who would carry descriptive botany to such a point of refinement that only the close specialist can know the forms. Under such circumstances, systematic work defeats its own ends.

It is, after all, to the plants of the older lands that the systematist must constantly bring his closer observation, new measurements, accumulation of facts, keener judgments, truer interpretation of environment, profounder estimation of relationships that can be expressed by classification. He is not merely a describer of novelties, giving new names; he discriminates, re-defines, applies the results of latest collateral science, suggests new meanings. His studies, as any others, must be kept alive and up to date. He must continually better serve any student of plants. There is no more end to the work of the systematist than to that of the geneticist.

Every large or variable group needs to be reworked at least every twenty-five years. In fact, it is an advantage to have a group worked simultaneously by separate monographers, that we may have more than one method and more than one judgment brought to bear on the problem. We must outgrow the idea that there is any finality in even the best monograph. Frequent review and sifting of evidence are as necessary in systematology and taxonomy as in morphology.

We do not realize that there is now appearing the modern systematist, who is not an herbarium hack, but a good field man, an evolutionist and plant geographer, one highly skilled in identification, and reinforced by much collateral training of a highly specialized character. This man has come quite unaware to most of us. Among the phytographers are those who are primarily cataloguers, sorters and bibliographers, of great skill; but the real systematist is a highly trained scientist.

I regret that the contribution of this man is frequently so little evidenced in the processes of college teaching. Graduates may be sent forth to instruct in botany so innocent of kinds of plants and of the means of finding them out as to be lost when placed in a strange country, wandering blankly among the subjects they are supposed to teach.

I have said that the systematist is specially needed in the older lands. I wish now to press this remark still farther by saying that he is much needed in the oldest and best known genera. What are known as the older species, as well as older genera, are likely to be least understood, for knowledge becomes traditional and they pass unchallenged. It is exactly in the old and supposedly well-known species that we are now making so many segregates.

It may be difficult, in any given monography, to express these different aptitudes of the systematist. Some subjects or problems do not exhibit the features that I have suggested nor admit of the application of such broad and deep investigations, even though the study and publication of them may be very much worth doing. Yet, the field of systematic work may be indicated, as an aim.

THE SITUATION IN THE CULTIVATED FLORA

No plants go unchallenged so completely as those of widespread, common and ancient cultivation. The treatment of them is particularly traditional. There may be no "types" representing them in herbaria. Origins may be repeated, perhaps even from the days of the herbalists. Statements are passed on from book to book and generation to generation. The plants are taken for granted. Yet when we come to study them critically we find that they may contain "new species," those that have passed all this time unrecognized. Any field that has been long neglected is sure to yield new harvests. The cultivated plants now provide some of the best botanizing grounds.

A few examples will illustrate what I mean. As a very simple illustration I may cite the case of the plant cultivated as *Malvastrum capense*. The species (as *Malva capensis*) was founded by Linnæus. The description in the books has been correct; but when the horticultural material was critically examined in 1908 it was found be an unrecognized new species, although cultivated for more than a century. It is now named *Malvastrum hypomadarum* Sprague. Another new species has recently been separated by Sprague in the material commonly grown in greenhouses as *Manettia bicolor*. The cultivated stock is clearly of two species, *M. bicolor* being Brazilian, and the new *M. inflata* being Paraguayan and Uraguayan. A case may be cited also in one of the commonest abutilons. The plant grown as *A. striatum* Dicks, is found to be really *A. pictum* Walpers, with the true *A. striatum* probably not in cultivation; and part of the greenhouse material, long cultivated, was separated as a new species, *A. pleniflorum*, as late as 1910 by N. E. Brown. Moreover, the plant still grown as *A. Thompsonii* is found to be not that plant, the material now cultivated in England under that name being recently described as *A. striatum* var. *spurium*, and that in America being apparently of several unidentified forms. In the meantime, the original *A. Thompsonii* appears to have been practically lost. Now, this situation directly involves the integrity of the so-called bigeneric graft-hybrid *Kitaibelia Lindemuthii*, one of the parents of which is recorded as *Abutilon Thompsonii*.

These are cases of erroneous determination and of confusion in forms, representing one of the commonest kinds of puzzles in the study of cultivated plants. The difficulty lies in the fact that systematists have not taken the trouble to look the cases up, accepting the plants from literature, and also in the fact that herbaria usually do not adequately represent such plants. The student may search in vain for authoritative early material of most long-cultivated plants, even in the best herbaria.

One of the present necessities is to collect the cultivated plants in their different forms from many localities, and representing the stocks of different dealers, in precisely the same spirit in which feral plants are taken for herbaria. Without such sources of information, we can neither understand the systematology of the plants themselves or bring the best aid to the student of heredity.

[The speaker here mentioned the lack of record material in studies of the systematology of *Coleus* and other groups; and explained also the unsatisfactory practise on which descriptions of large numbers of cultivated species still must rest.]

Excellent illustration of the confusion in cultivated plants, even of relatively recent introduction, is afforded by the velvet-beans now grown in the southernmost states. These plants have been referred indiscriminately to *Mucuna pruriens*, long cultivated in the tropics. On careful recent study, however, the American planted material is found to be so different from *Mucuna* as to necessitate generic separation, and the genus *Stizolobium* has been revived to receive it. The common cultivated velvet-bean is found by Bort to be an undescribed species, probably of oriental origin, and it has been named and described *Stizolobium Deeringianum*. Subsequently other species have been newly described in the cultivated stocks. One need not go far for many comparable illustrations of the confusion in which cultivated plants have lain. Americans are now specially active in resolving these complexities. As a running random comment may be cited the work of Rose in the cacti, Swingle in *Citrus*, Rehder in *Wisteria*, oriental *Pyrus* and others, Wilson in Japanese cherries, Safford in Annonaceæ. It is not too much to say that any of the important groups of cultivated plants will fall to pieces as soon as touched by the competent modern systematist.

The systematist who works in these domesticated groups must first make large collections of new information and material. It is becoming a habit with him to travel extensively to study the plants in their original countries, and to bring history and ethnography to bear on the problem. He is not content until he arrives at sources.

[The speaker discussed, and illustrated with herbarium material, the recent studies in the cultivated poplars, whereby the subject has been opened for discriminating investigation.]

Nor does the confusion lie only with plants of ancient domestication or with those native to countries which have not yet been well explored. The horticultural blackberries have been brought into cultivation from American wild stocks within seventy-five years or less, they have been accorded careful study by several specialists, yet no one is ready to name the species from which the different forms have come. A number of systematists are working on them, and yet they are in need of further study, both in the wild and in cultivation. In *Prunus* is a comparable case, horticultural forms in many named varieties of native plums having come into cultivation within fifty years. It fell to my hand to attempt the first critical taxonomic writing of these native plants, in 1892; but in 1915 Wight completely recast the treatment, in the light of accumulated experience. This illustrates my earlier remark that every group should be newly monographed at frequent intervals.

Perhaps we do not sufficiently realize the great numbers of species of plants now in cultivation. We may have in mind the 247 species studied by DeCandolle in his

"Origin of Cultivated Plants." These are only food plants, and the treatment does not pretend to be complete. In the Standard Cyclopedia of Horticulture, the entries of plants described in cultivation exceeds 20,000, although not nearly all these species are domesticated. About 40,000 Latin names are accounted for. This treatment does not cover the cultivated plants of the world, but those of the United States and Canada and those readily drawn from the European trade, with the most prominent species in the island dependencies of the United States. Probably never have species new to cultivation been introduced so rapidly as within very recent years. For example, in the treatment of *Primula* in the Cyclopedia of American Horticulture in 1901, I described twenty-seven species; in the Standard Cyclopedia in 1916, I described 200. All this phalanx comprises in itself a large section of the vegetable kingdom, perhaps as much as nearly one sixth of the Spermatophyta, and it demands the attention of the best phytographic and taxonomic investigation.

The long-repeated statements of origins of cultivated plants are challenged whenever the systematology is seriously attacked, or when the subject is examined under botanical investigations. The case of maize is a striking example; although always explained on the basis of American origin, the reported pre-Columbian references in China need further investigation. The same kind of puzzle associates with many plants, wild as well as domesticated, that are prominent subjects in early travels and writings. Thus Fernald concludes that the wine-berries of the Norsemen were not grapes found on the shores of the present New England, as we have always assumed, and that they were probably mountain cranberries found in Labrador or the St. Lawrence region. The result of contemporaneous studies is that, from both the historical and biological sides, the foundations are being shocked. Most of my life I have given special attention to the botany of the domesticated flora, yet I should not now care to hazard a pronouncement from this platform on the specific natural-history origin of any one of the more important widespread species of cultivated plants.

THE SYSTEMATIST IS A BIOLOGIST

Whether he works with feral or domestic floras, the systematist of whom I speak is a real investigator. He studies the living material so far as he is able, perhaps growing it for this purpose; tries to understand the influence of environment, the rôle of hybridization and mutation, and preserves his records in the form of ample herbarium sheets. He relates his work to morphology, and desires to arrange it as an expression of lines of development. He may study his material for years before he ventures to describe. It follows that the systematist necessarily, in these days, becomes a specialist; and it further follows that we should encourage, in addition to the few very large and comprehensive establishments, the making of many herbaria and growing collections strong in special lines.

L. H. BAILEY

PATENT REFORM PROSPECTS

THE Patent Office Society is permitted to announce that a composite committee has been created, upon request, by the National Research Council, to make a preliminary study of the problems of the U. S. Patent Office and its service to science and the useful arts. This committee, which is expected to meet in Washington shortly after the middle of December, is understood to comprise, at the outset, the following: Leo H. Baekeland, Wm. F. Durand, Thos. Ewing, Frederick P. Fish, Robert A.

Millikan, Michael I. Pupin and S. W. Stratton.

The action of the National Research Council in forming a committee of this sort is understood to be in conformity with the wishes of Commissioner of Patents J. T. Newton and Secretary of the Interior F. K. Lane, and to be in accord also with the following resolutions originally adopted by the Patent Office Society and concurred in by Mr. Ewing while commissioner of patents:

WHEREAS a section of the charter of the National Academy of Sciences provides that "The academy shall, whenever called upon by any department of the government, investigate, examine and report upon any subject of science or art,"

AND WHEREAS, at the request of the President of the United States, the academy has organized a National Research Council, to bring into effective cooperation existing governmental, educational and other research organizations,

AND WHEREAS the National Research Council is now perfecting its organization for the performance of the above duties,

AND WHEREAS a fundamental activity of the Patent Office is research upon questions of novelty, "in order to promote the progress of science and the arts" by the prompt issuance of proper grants and the refusal of improper grants of patent monopolies,

Now therefore be it resolved by the Patent Office Society:

1. That in its judgment a request for cooperation, advice and assistance should be promptly forwarded to the National Research Council, attention being called to such problems as adequacy of force, adequacy of space, adequacy of library, adequacy of facilities for test and demonstration, adequacy of classification, adequacy of organization, adequacy of scientific, legal and professional standards, adequacy of incentives and opportunities, simplification of procedure, responsiveness to present national and international requirements and to the important advances that might be expected either from an independent study of the above by the National Research Council or from an early effort on its part to coordinate, in the interest of an improved public service, the endeavors of the various national societies, manufacturing interests, patent bar associations, and all others aiming at genuine patent reform.

2. That the concurrence of the Commissioner of Patents and the Secretary of the Interior in these resolutions be solicited.

3. And that a copy hereof be forwarded to the National Research Council with some expression of the appreciation of this society for the interest already shown, and some appropriate assurance of the determination of this society to render every possible assistance and support to the work of the National Research Council.

The implied determination of the Patent Office Society to do its part in an effort to improve the work and conditions of the Patent Office, and to gain therein all possible support on the part of scientists, engineers and manufacturers, is further indicated in the accompanying resolutions relating to the proposed Institute for the History of Science, for which a Washington location is by it advocated—this latter proposal being already accorded the invaluable support of the Washington Academy of Sciences.

RESOLUTIONS ADOPTED BY THE PATENT OFFICE SOCIETY, BY ITS AUTHORISED EXECUTIVE COMMITTEE

That the attention of all interested in the possibilities of the proposed Institute for the History of Science be called to the advantages of such a location and organization for that institute, whenever it shall be established, as shall render its resources easily available not only to highly trained specialists but also to practising engineers, to examiners of patents, and, so far as practicable, to the general public.

That, in the judgment of the Patent Office Society, the present moment of prominence of American ideals and of recognised dependence upon the facts and principles of science is none too early for preliminary steps toward the establishment in this country of an Institute of the general character already proposed (by George Sarton, and others, in SCIENCE, March 23, 1917), such institute to be independent, liberally endowed and adequate not only to the requirements of our present national life, but also to that great era of internationalism and general enlightenment upon which even the avoidance of war may hereafter depend.

That the special committee in hand relations with the National Research Council be directed to emphasise to that body the foregoing conclusions as perhaps pertinent to purposes shared by it; to solicit the concurrence therein of both the local and the national scientific and engineering societies, and to publish the same generally, or in its discretion, always with careful regard to the aims of those to whom the project is due.

The following questions raised in a report made to the Patent Office corps by a special committee charged to cooperate with the personnel committee of the National Research Council will indicate something of the tendency of measures for which it is hoped to gain early consideration:

What does the Patent Office need besides men and materials?

Feeling that the time is at hand when the Patent Office must enter upon either a period of very rapid decline or else upon a period of revitalization and expansion, shall we not test the notion that it may actually be easier, and in every respect better, for the office, exhibiting a new vision of its task, to ask a great deal more, rather than to continue its petition for the very, very little that has so often been denied it?

Relying upon the assistance of the composite committee generously formed by the National Research Council—

Can assistance be got, even now, in the making of a genuine advance in the indispensable work of reclassification of patents and of literature?

Can all who are employed in the work of examination be in any way further encouraged and aided to become specialists in one or another of the branches of applied science—rather than mere rule-parrots and picture-matchers? And would a proposed departmental organization of the office aid to this end?

Can these gains against dilatory prosecution made under the energetic efforts of Commissioner Ewing be rendered secure for the future by (*e. g.*), dating the terms of patent monopolies from the date of filing—in order to create an incentive for diligent rather than dilatory prosecution?

Could any adjustment of extra fees for extra claims discourage the "fog-artists" and create an incentive for a more genuine effort on the part of attorneys to find the meat of the coconut—instead of putting it up to the office, the courts or the public to do so?

Can any elevation of the standards of practise (effected perhaps with the assistance of the patent bar) relieve the office at the same time from an undue burden of editorial work and from any suspicion of complicity in the wholesale netting of "suckers" by men who indulge in misleading advertisements or contingent prosecution?

Can the divisions of the office advantageously be grouped into departments, each comprising several divisions handling analogous problems—a chemical department, an electrical department, an "instrument" department, a motive power department and the like, each under some expert of distinction in a particular field, and this body of experts having not only authority within their respective departments, but exercising collectively an enlightened and final appellate jurisdiction?

Can the salaries of these proposed department heads (constituting an enlarged and strengthened board) and the salaries of chiefs of divisions, and of others, be made such as to justify able and provident men in remaining for a much longer average term within this branch of the service?

Could the establishment in Washington of some great related institution, such as the proposed Institute for the History of Science, aid materially by an assembling, in this vicinity, of permanent exhibits genuinely illustrative of the advance of, *e. g.*, the chemical arts, the electrical arts, the motive power arts, the transport arts, etc., with a corresponding assembling and arrangement of pertinent literature from all the world, and with such an administrative organization as shall supplement the resources of this office, among others, sustaining its standards, while at the same time providing, in support of those who can maintain their scholarly interests and professional instincts, something of the stimulus and the opportunities of a true national university?

The mentioned special committee of the Patent Office Society takes this means of urging upon all interested the forwarding of any patent reform suggestions at once to Dr. Wm. F. Durand, National Research Council, Washington, D. C. It is not expected that patent reform can claim primary consideration during the continuance of the war, but it is felt that the time is ripe for at least a study of conditions and a renewed consideration of certain fundamentals from which it is felt that the office—charged "to promote the progress of science and the useful arts"—has departed through lack of information and support.

Bert Russell, *Secretary*,
H. J. Jewett, *Chairman*,
Special Committee, Patent Office Section

SCIENTIFIC EVENTS

FREE PUBLIC MEDICAL LECTURES

The faculty of medicine of Harvard University offers a course of free public lectures on medical subjects to be given at the medical school, Longwood Avenue, Boston, on Sunday afternoons at four o'clock, beginning January 6 and ending April 21, 1918.

January 6. Social hygiene and the war, Dr. Wm. F. Snow, major, Medical Reserve Corps, U. S. A.

January 13. Surgical shock, Dr. W. T. Porter.

January 20. Teeth and their relation to human ailments; a plea for conservation, Dr. G. H. Wright.

January 27. Home nursing, with demonstrations, Elizabeth Sullivan.

February 3. Child welfare during the war, Dr. Richard M. Smith.

February 10. Child welfare, Miss Mary Beard.

February 17. Shoes and structure of the foot, Dr. E. H. Bradford.

February 24. Social infection and the community, Bishop Lawrence.

March 3. The deformed mouth of a child; its effect on the child's future, Dr. L. W. Baker.

March 10. Food: how to save it, Dr. L. J. Henderson.

March 17. What to eat during the war, Dr. F. W. White.

March 24. Some aspects of fatigue, Dr. Percy G. Stiles.

March 31. Camp sanitation and control, and hospital administration at Camp Devens, Dr. Glenn I. Jones, major, Medical Corps, U. S. A.

April 7. Accident and injury, first aid (with simple demonstrations), Dr. J. Bapst Blake.

April 14. Immunity to contagious disease, Dr. E. H. Place.

April 21. Hay fever and asthma, Dr. I. Chandler Walker.

April 28. Food administration during the war, Dr. Julius Levy (under the National Food Committee).

THE POPULAR MEDICAL LECTURES TO BE GIVEN AT THE STANFORD UNIVERSITY MEDICAL SCHOOL DURING JANUARY, FEBRUARY AND MARCH, 1918

The program is as follows:

January 4. The control of vice diseases among troops through civil and military cooperation, Colonel L. U. Maus, U. S. Army.

January 18. Surgery of the present war, Dr. Leo Eloesser.

February 1. Industrial fatigue, Professor E. G. Martin.

February 15. Food poisoning from canned goods, Dr. E. C. Dickson.

March 1. Recent experiences of a medical man in the war zone, Dr. William P. Lucas, professor of pediatrics, University of California.

March 15. Circulation of the blood, Dr. A. A. D'Ancona. Illustrated with moving pictures.

WARTIME WORK OF THE FOREST SERVICE

How the work of the Forest Service was realigned to meet war conditions is described in the Annual Report of the Forester, which in the absence of the head of the service is made by Acting Forester A. F. Potter. The report also states that practically every form of use of the forests was greater than ever before, that the receipts again touched a new high level with a total of $3,457,028.41, and that the increase in receipts over the previous year was $633,487.70.

"When the grazing charge has been advanced to cover the full value of the grazing privilege," says the report, "the income from the national forests will be close to the cost of operation. The present annual cost is about $4,000,000." An increase equal to that of the last fiscal year "would close the gap."

The Forester, Henry S. Graves, is now serving with the American Expeditionary Forces in France, with a commission as lieutenant colonel, in connection with the forest work for the supply of the needs of our overseas troops and those of the Allies. A number of other members of the Forest Service received commissions in the Tenth Engineers (Forest) while many more entered the ranks.

Wood and other forest products have almost innumerable uses in modern warfare. Never before has the demand for exact knowledge been so urgent. "In the work relating to forest utilization and forest products, the resources of the service have been employed to the limit of their capacity since the war began in rendering assistance to the War and Navy Departments, the Emergency Fleet Corporation, various committees of the Council of National Defense, and manufacturers of war orders. The peace-time program has been largely discontinued. The force and the work have been centered in Washington and Madison. Every effort has been made to bring available knowledge to the attention of the organizations which have need for it and to assist in anticipating their problems."

Much of the work has concerned aircraft material. It has included also problems connected with the construction of wooden ships and of vehicles. Assistance has been given to hardwood distillation plants in order to increase the production of acetone and other products needed for munition making. A commercial demonstration has shown that costs of producing ethyl alcohol from wood waste can be materially reduced. Methods have been developed by which walnut and birch can be kiln-dried in a much reduced time with comparatively little loss. In general, the report says, "much assistance has been given on a great variety of war problems relating to forest resources and the manufacture, purchase, and most efficient use of wood and other forest products."

In spite of the many new demands upon the Service and the entrance upon military duties of a considerable number of its men, the administrative and protective work on the national forests was continued without disorganization. "Upon request of the War Department the preliminaries of recruiting and officering the Tenth Engineers (Forest) were handled. Increase of crop production in and near the forests was stimulated and the forage resource of the forests was made available for emergency use up to the limit of safety. In the latter part of the summer a fire season of extreme danger, made worse in some localities by an unusual prevalence of incendiarism, was passed through with relatively small loss of property and with no reported loss of life."

WAR ACTIVITIES OF THE GEOLOGICAL SURVEY

THE activities of the Geological Survey, Department of the Interior, during the fiscal year 1916–17 have been concentrated on investigations connected with military and industrial preparedness, as shown by the Annual Report of the director of the survey, just made public. These activities have included the preparation of special reports for the War and Navy Departments and the Council of National Defense, the making of military suveys, the printing of military maps and hydrographic charts, and the contribution of engineer officers to the Reserve Corps.

The survey's investigations of minerals that have assumed special interest because of the war have been both expanded and made more intensive. Special reports giving results already at hand, the product of years of field and office investigation, have been published for the information of the general public or prepared for the immediate use of some official commission, committee or bureau. Geologic field work has been concentrated on deposits of minerals that are essential to the successful prosecution of the war, especially those of which the domestic supply falls short of present demands. Every available oil geologist is at work in petroleum regions where geologic exploration may lead to increased production. Other geologists are engaged in a search for commercial deposits of the "war minerals"—manganese, pyrite, platinum, chromite, tungsten, antimony, potash and nitrate.

The war not only diverted practically all the activities of the topographic branch of the survey to work designed to meet the urgent needs of the war department for military surveys, but led to the commissioning of the majority of the topographers as reserve officers in the Corps of Engineers, United States Army.

A large contribution to the military service is made by the map-printing establishment of the survey. This plant has been available for both confidential and urgent work, and during the year has printed 96 editions of maps for the war department and 906 editions of charts for the navy department. Other lithographic work, some of it very complicated, was in progress at the end of the year.

During the year the survey published 208 scientific and economic reports, and at the end of the year the survey members holding appointments from the secretary numbered 934, an increase of 62.

SCIENTIFIC NOTES AND NEWS

The American Association for the Advancement of Science begins its annual meeting at Pittsburgh on the day of issue of the present number of Science. The address of the retiring president, Dr. Charles R. Van Hise is given this evening, his subject being "Economic Effects of the World War in the United States." It is expected that the meeting of the association and of the national societies meeting at the same time will be smaller than usual, and that scientific problems of national concern at the present time will occupy most of the programs. Careful consideration was given to the desirability of holding the meeting. It was decided that the service it could render to science and the nation was far greater than any drawbacks. This was the opinion both of scientific men and of the officers of the government who were consulted.

Sir Archibald Geikie, who has long been a correspondent of the Paris Academy of Sciences, has now been elected an associate member of the academy.

Dr. William W. Keen, of Philadelphia, has declined the renomination of president of the American Philosophical Society, after serving ten years in that capacity.

Dr. Alexis Carrel, having been detained in America by official duties, the Harben lectures he was to have delivered in England at the end of this month have been postponed.

Gilbert N. Lewis, professor of physical chemistry and dean of the college of chemistry in the University of California, has been granted leave of absence for the half year beginning January 1, 1918, to serve as major in the Ordnance Department of the U. S. Army. He is to go at once to France.

Mr. Charles S. Wilson, state commissioner of agriculture of New York, has been reappointed to that office by the newly organized Council of Farms and Markets at Albany. His original appointment was made almost three years ago by the governor. Mr. Wilson was then professor of pomology in the State College of Agriculture at Cornell.

Dr. Frank C. Hammond has been appointed a member of the Philadelphia Board of Health to serve during the absence in France of Dr. Alexander C. Abbott.

A number of additional members of the University of California faculty have entered Army service, including Joel H. Hildebrand, associate professor of chemistry, now a captain in the Ordnance Department; Dr. A. L. Fisher, assistant in orthopedic surgery, now a captain in the U. S. Medical Reserve, attached to Base Hospital No. 30; and W. F. Hamilton, A. R. Kellogg, and J. B. Rogers, of the department of zoology, now in the Forestry Reserves.

F. G. Tucker, assistant professor of physics at the State College of Washington, has been granted leave of absence to take up his duties as second lieutenant in the U. S. Coast artillery.

The council of the Royal Meteorological Society has awarded Dr. H. R. Mill the Symons gold medal for 1918 "for distinguished work in connection with meteorological science."

The following letter has been received by the Duke of Connaught, President of the Royal Society of Arts from Mr. Orville Wright, of Dayton, Ohio.

> I have the pleasure of acknowledging the receipt of your Royal Highness's letter and the Albert Medal of the Royal Society of Arts, which were forwarded to me through the British Ambassador at Washington. I wish to express my appreciation of the honor conferred upon me by the Royal Society of Arts as a recognition of the work of my brother Wilbur and myself towards the solution of the problem of flight. I appreciate with the utmost gratification the honor of being placed by your society among such men as those to whom this coveted medal has been awarded in years past.

Professor Frederick Starr, of the department of sociology and anthropology at the University of Chicago, who has been in the Orient for the past year on leave of absence, will renew his work at the university with the winter quarter, giving courses in prehistoric archæology and general anthropology. Professor Starr has been conducting special anthropological investigations in Korea and has published a book of some five hundred pages in Japanese. He has also published a paper on "Korean Coin Charms," which is issued by the Korean branch of the Royal Asiatic Society. Before leaving Japan Professor Starr gave two public addresses, one before the Tokyo Anthropological Society and one before the Asiatic Society of Japan.

Professor Charles Baskerville, professor of chemistry and director of laboratories of the College of the City of New York, delivered a lecture at the Royal Canadian Institute, Toronto, Canada, on December 8, the subject being, The Hydrogenation of Vegetable Oils.

Dr. E. O. Hovey, of the American Museum of Natural History, delivered a public address on "Two years in the far North" at Syracuse University on December 7, under the auspices of the Sigma Xi Society.

Professor O. D. von Engeln, of Cornell University, addressed the Physiographers' Club of Columbia University on November 23 on "Types of Alaskan glaciers and features of the associated deposits."

Sir Arthur Newsholme gave this year the Lady Priestley Memorial Lecture of the National Health Society. The subject was "The child and the home."

Dr. Louis Pope Gratacap, for the last twenty-seven years curator of mineralogy and a member of the staff of the American Museum of Natural History for forty-one years, died at New Brighton on December 19, aged sixty-seven years.

Dr. Charles M. Mansfield, scientific assistant in the Biochemic Division of the U. S. Bureau of Animal Industry, died at his home in Washington, D. C., on December 17. Dr. Mansfield was an accomplished photographer and had contributed several articles to the photographic journals.

The death is announced at the age of 48, of Dr. J. Rambousek, professor of factory hygiene, and chief state health officer, Prague.

Lieut. Cyril Green, known for his work in plant ecology and the physiological anatomy of water plants, was killed on the Palestine front early in November. He had been a member of the staff of the department of botany of the University College, London. Since the outbreak of the war he had been appointed head of the department of botany in the new Welsh National Museum at Cardiff, a position which was to have been held open for him until the conclusion of hostilities.

The death is announced on November 4 of M. R. Nichéls, professor of geology in the University of Nancy.

The Society of American Bacteriologists will hold its annual meeting in Washington, D. C., on December 27, 28 and 29. The morning and afternoon sessions will be held in the new National Museum. The president is Dr. Leo F. Rettger, New Haven, Conn.; the secretary, Dr. A. Parker Hitchens, Glenolden, Pa.

At their recent annual meeting the board of trustees of the Carnegie Institution of Washington accepted from Mrs. E. H. Harriman the gift of the Eugenics Record Office at Cold Spring Harbor. This gift comprises about 80 acres of land, the office building with its records and other contents, the large residence and other buildings. In addition Mrs. Harriman has given to the trustees of the institution securities yielding an annual income of $12,000, as a fund for the office. The total valuation of the gift is about half a million dollars. The transfer has been made by Mrs. Harriman in order to ensure the permanent continuation of the work of the Eugenics Record Office. Except that the former board of scientific directors is dissolved the immediate management and personnel of the office have not been affected by the transfer.

The regular monthly meeting of the California Academy of Sciences was held on December 19, when a lecture was given by Professor J. C. Bradley, Cornell University, on "The Okefinokee" (illustrated). Following the lecture Dr. Barton W. Evermann spoke briefly concerning the establishment of Federal Fisheries Experiment Stations. The course of popular scientific lectures is being continued on Sunday afternoons at 3 o'clock in the auditorium of the Museum in Golden Gate Park. Announcements are made as follows:

December 16, The growth and transformation of insects (illustrated): Professor E. O. Essig, College of Agriculture, University of California.

December 23, The distribution of plants in California (illustrated): Professor Douglas Campbell, Department of Botany, Stanford University.

December 30, A fiesta of Indian summer: Professor C. L. Edwards, Director of Nature Study, Los Angeles Schools.

January 6, Midwinter birds of Golden Gate Park (illustrated): Professor Joseph Grinnell, Director of the Museum of Vertebrate Zoology, University of California.

January 13, Fish and game in California (illustrated by motion pictures): Dr. H. C. Bryant, Game Expert, California Fish and Game Commission.

The next meeting of the Botanical Society of Washington will be held at the Cosmos Club, Washington, D. C., January 8, 1918. Abstracts of the papers presented will be published in the *Journal* of the Washington Academy of Sciences. The program is as follows:

The botany and economics of the tribe Phaseoleæ, C. V. Piper.

Morphological characters and food value of soybean varieties, W. J. Morse.

Fermented soy-bean products, Dr. Chas. Thom.

The American species of the genus *Phaseolus*, Dr. D. N. Shoemaker.

The *Journal of the British Medical Association* reports that at a meeting of the Société Internationale de Chirurgie in Paris on November 3, 1917, which was attended by delegates from Belgium, France, Great Britain, Serbia, and the United States, it was resolved to dissolve the society after the publication of the volume of *Transactions* of the meeting held in New York on April 14, 1914. It was further resolved that, should there be any assets after the publication of this volume, the money shall be divided *pro rata* amongst the members, so that each member of the Germano-Austrian group shall receive his share, but that the shares belonging to members of other nations shall be retained and applied to some object of scientific reparation in Belgium. The meeting then determined that a new society shall be formed after the war on a basis similar to that of the Société Internationale de Chirurgie. It will be called the Société Interalliée de Chirurgie, but will be open also to such surgeons of neutral countries as may be nominated for election by the general committee.

A new journal of neurology and psychiatry in German, French and Italian has recently appeared under the direction of C. Von Monakow, professor of neurology in the University of Zurich, with the collaboration of all the well known Swiss neurologists and psychiatrists. The assistant editors in neurology are Dr. Bing (Basel), Dr. Minkowski (Zurich), and Dr. Naville (Geneva); in psychiatry, Professor Dr. Weber (Geneva) and Professor Dr. Maier (Zurich).

Dr. F. W. Clarke, chairman of the International Committee on Atomic Weights, writes in the *Journal* of the American Chemical Society that on account of the difficulties of correspondence between its members, due to the war, the International Committee on Atomic Weights has decided to make no full report for 1918. Although a good number of new determinations have been published during the past year, none of them seems to demand any immediate change in the table for 1917. That table, therefore, may stand as official during the year 1918.

The Science Club of the University of Oregon recently elected the following officers for the ensuing year: *President*, Dr. W. D. Smith, of the department of geology; *Secretary*, Dr. C. H. Edmondson, of the department of zoology. The following program has been arranged for the year:

November.—"Symposium on research," Professor O. F. Stafford, *chairman*.

December.—"Some research among northwest Indians," Mr. Frank Hall, curator, Washington State Museum, University of Washington.

January.—"The relation of physical to mental growth," Dr. B. W. DeBusk.

February.—"Thermo-electric properties of alloys," Dr. A. E. Caswell.

March.—"Investigations relating to the conservation and utilization of our fish resources," Professor H. B. Torrey, Reed College.

April.—"A rational map of Europe," Dr. Rebec.

May.—"Biologic investigations in southern California," Mr. Shelton.

The chief signal officer requests that help be given to the Signal Corps of the army to obtain lenses enough for cameras for the fleet of observation airplanes now being built. The need is immediate and of great importance; the airplanes are the eyes of the army and the camera lenses are the pupils of those eyes. German lenses can no longer be bought in the open market. England met this difficulty in the earlier stages of the war by requiring lens owners to register lenses and requisitioning those needed. The Bureau of Standards of the United States Department of Commerce is now perfecting a substitute for the German "crown barium" glass used for lenses and will later be able to meet the needs, and special lenses are being designed for this work. The situation now, however, is that, with airplanes soon to be ready for service, suitable lenses can not be bought. Hundreds are needed at once. Possessors of the required types are urged to enlist their lenses in the army. They are asked immediately to notify the photographic division of the Signal Corps, United States Army, Mills Building Annex, Washington, D. C., of lenses of the following descriptions which they are willing to sell, stating price asked: Tessar anastigmat lenses, made by Carl Zeiss, Jena, of a working aperture of F. 3.5 or F. 4.5 from 8¼ to 20 inches focal length. Bausch & Lomb Zeiss tessars, F. 4.5, from 8¼ to 20 inches focal length. Voigtlander Heliar anastigmat lenses, F. 4.5, 8¼ to 20 inches focal length.

Secretary Lane, of the department of the interior, on August 16, formally authorized the establishment of a new mining experiment station under the jurisdiction of the school of mines at the University of Minnesota. Minnesota is one of two institutions to be so designated. The other bureau was established at Columbus, Ohio, the recognized center of the clay-working industries of the United States. In recommending the University of Minnesota to Secretary Lane for the site of one of the proposed stations, Director Manning, of the bureau, said that at the present rate of production the high grade ores of Minnesota will become almost exhausted the next thirty years and it will be the duty of the bureau to endeavor to show the way to utilize the huge deposits of low-grade ores if the industry is to continue to prosper. The station is to work in a cooperative way with the University of Minnesota, an agreement to that effect having been signed by both parties.

During the past summer, Professor C. H. Edmondson, of the department of zoology of the University of Oregon, has been conducting a survey of the shellfish resources of the northwest coast, under the direction of the U. S. Bureau of Fisheries. The survey is a part of the general conservation of food campaign undertaken by the federal government. In the course of the work the coast of Oregon has been traversed from about five miles south of Bandon to the mouth of the Columbia River and the Washington coast north to Gray's Harbor. All the important bays and inlets were visited and the species and relative abundance of the edible clams noted. The purpose of the survey, however, is not merely to determine the location of the edible shellfish, but to aid in all possible ways the increase of this type of food supply and to encourage the general public to make greater use of clams and mussels as a partial substitute for the higher priced meats. Few realize the abundance of food represented by the immense quantities of shellfish distributed along this coast or how cheaply edible clams may be obtained from the towns of Marshfield, Florence, Newport or Tillamook. In view of the fact that little is known of the life history of any of these shellfish of our coast, Professor

Edmondson has initiated experimental work at Florence, Newport and Tillamook for the purpose of determining the rapidity of growth, the age, the spawning season and the conditions under which certain of the edible clams best thrive. These experiments will be carried on throughout the year or until satisfactory results are obtained.

A questionnaire was recently circulated among the members of the Chartered Institute of Secretaries of Great Britain for the purpose of obtaining opinions in regard to the adoption of a decimal system of coinage in the United Kingdom, and the substitution of the metric system for the existing United Kingdom weights and measures. Of the replies received 85 per cent. considered that a change to a decimal system of coinage would be favorable to the business in which they were engaged, and 66 per cent. favored a £1 basis of coinage in preference to the "Imperial Crown" or dollar basis. In regard to weights and measures, 86 per cent. favored a change to the metric system, 53 per cent. of whom already used that system in their business. One member expressed the opinion that a strong commission of able men should be asked to decide whether the continental system, which was forced upon countries at a time when violence, rather than reason, prevailed, had been really satisfactory.

UNIVERSITY AND EDUCATIONAL NEWS

In honor to Andrew S. Hallidie, inventor of the use of the cable railway for passenger traffic in cities, who was a regent of the University of California from 1878 to 1900, the regents of the university have given the name "Hallidie Building" to a building which they are now erecting in San Francisco as an investment of University endowment funds.

W. J. Spillman, chief of the office of farm management, U. S. Department of Agriculture, has accepted the deanship of the newly created college of agriculture at the State College of Washington. He will take up his new duties April 1, 1918, after he has completed a survey of the farm labor situation in the United States, upon which he is engaged as an emergency war measure.

A department of plant pathology has been created by the regents of the State College of Washington, Dr. F. D. Heald, formerly professor of plant pathology, has been made head.

Professor F. L. Washburn of the University of Minnesota has been relieved of his present position in the Agricultural College and station and as state entomologist, and has been given the title of professor of economic vertebrate zoology, to take effect on February 5.

Dr. A. L. Tatum, professor of pharmacology in the University of South Dakota, has been appointed assistant professor of pharmacology and physiology in the University of Chicago.

Mr. Roy Richard Denslow, assistant tutor in the department of chemistry, College of the City of New York, has been appointed instructor in Smith College.

DISCUSSION AND CORRESPONDENCE

THE PITTSBURGH MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

[The following letter was delayed in the mails and reached Science just too late for publication in the last number.]

To the Members of the American Association for the Advancement of Science:

When the American Association for the Advancement of Science and all similar societies planned their winter meetings, the present situation could not have been foreseen. We had not even entered the war, and did not dream of a congestion of transportation such as now exists. When the present situation had developed, it was (in the opinion of a majority of the committee having power) too late to postpone our meeting.

Transportation is now so greatly overtaxed that necessaries of life can barely be carried; the railways should be spared every extra burden. Great simultaneous pilgrimages on important trunk lines are especially to be avoided, since they demand extra trains, need-ing extra locomotives and coal, and causing much confusion. Therefore, in my opinion it behooves every patriotic and unselfish member to consider very seriously whether he can really serve his country by attending the meeting, or whether he can not better serve in this fateful time by staying at home, especially during a period of highly congested travel, when many of our soldiers may wish to take leave of their families before departing for the front. I believe that only those persons bringing really important contributions to the problems of the war should attend such meetings now. All others, in my opinion, should conserve their money for Liberty bonds and for those in distress, and should save their strength for action in this time of extraordinary crisis. For these reasons, with great regret, I have decided not to attend the meeting at Pittsburgh.

So far as I have been able to ascertain, all the responsible authorities at Washington concerned with transportation agree with me as to the importance of avoiding unnecessary journeys in such a crisis.

The very great usefulness of the American Association for the Advancement of Science is not dependent upon the unbroken continuity of its social meetings.

Science is incalculably important, indeed indispensable, in this world-wide cataclysm. The excellent work of the association in the past is now bearing fruit; but this moment demands action rather than general discussion. We must devote all our energies to winning the war. Let us all make every endeavor to apply our knowledge and strength in our country's noble cause.

THEODORE W. RICHARDS

CAMBRIDGE, MASS.,
December 15, 1917

THE BEARING OF THE FACTS REVEALED BY ANTARCTIC RESEARCH UPON THE PROBLEMS OF THE ICE AGE[1]

RECENT Antarctic explorations and researches have yielded significant evidence regarding the problems of the Ice Age, and, of the similarity of the succession of geological climates in polar with those in other latitudes.[2]

These researches have been prosecuted to the ultimate limit of courage, devotion to duty and endurance—the noble sacrifice of life—as in the cases of Captain Scott, R.N., and his devoted companions and members of the expedition of Sir Ernest Shackleton.

The data secured by these expeditions are alone sufficient to establish the following premises:

1. That Antarctic ice, although covering areas several times larger than all other ice covered areas, is slowly decreasing in extent and depth.

2. That the same succession of geological climates have prevailed in Antarctic as in other latitudes.[3]

So vital are these evidences of the retreat of Antarctic ice that it may be well to briefly quote or refer to the most prominent instances:

> All these evidences and many others which space will not allow me to mention lead up to one great fact—namely, that the glaciation of the Antarctic regions is receding.[4]
>
> The ice is everywhere retreating.[5]
>
> The high level morains decrease in height above the present surface of the ice, the débris being two thousand feet up near the coast and only two hundred feet above near the plateau.
>
> (Scott's lecture on the great ice barrier.[6])

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[1] This term as used by the writer refers to the Great Ice Age of Pleistocene Time. He holds that the occurrences of ice as a geologic agent of magnitude during eras preceding the Pleistocene were not "world wide" nor as "phenomenal," nor were they preceded, accompanied nor followed by conditions as significant as corresponding phenomena of the Ice Age. (Compte Rendû du XI ième Congrès Géologique International, p. 1105. Stockholm, 1910.)

[2] "Scott's Last Expedition," Vol. II., p. 206.

[3] This part of the evidence is not considered in this paper except inferentially as bearing upon the general subject.

[4] Scott, "The Voyage of the *Discovery*," Vol. II., page 416. See also pp. 423–24–25, and sketch map of ice distribution, p. 448.

[5] Scott, "National Antarctic Expedition, 1900–1904," Vol. I., p. 94.

[6] "Scott's Last Expedition," Vol. II., p. 294.

This observation applies to an ice-covered area of over 116,000 square miles.

Mr. Griffith Taylor notes the recession of Dry Valley Glacier twenty miles from the sea below Taylor Glacier.[7]

Mr. Taylor also notes and speaks with confidence of the passage of the Ice Age from Antarctica.[8]

In speaking of the evidence of ice retreat over Antarctic areas explored by him, Sir Ernest Shackleton said:

> Some time in the future these lands will be of use to humanity.[9]

This impressive and conclusive evidence is corroborated by the greater and still more impressive evidences of the comparatively recent uncovering of temperate land areas,[10] and the progressive retreat of the snow line to higher elevations in temperate and tropical latitudes and towards the poles at sea level, being far greater in Arctic than in Antarctic regions. We are therefore confronted with the conclusions:

1. That the disappearance of the Ice Age is an active present process and must be accounted for by activities and energies now at work, and that the use of assumptions and hypotheses is not permissible;

2. That the rates and lines of retreat are and have been determined by exposure to solar energy and the temperatures established thereby; and by the difference in the specific heat of the land and water hemispheres;

3. That the lines of the disappearance of ice are not conformable with those of its deposition, and mark a distinctly different exposure and climatic control from that which prevailed prior to the culmination of the Ice Age.

4. This retreat also marks a rise in mean surface temperature along these new lines, manifestly due to recently inaugurated exposure to solar radiation and also the inauguration of the trapping of heat derived from such exposure; which process is cumulative and has a maximum not yet reached.

The researches under the direction of Captain Scott and Sir Ernest Shackleton have therefore very rigidly conditioned any inquiry as to the causes of glacial accumulation and retreat. These conditions are CORRECTIVE and DIRECTIVE—*corrective*, in that they have entirely removed any doubts as to the alternate glaciation of the poles under the alternate occurrence of aphelion and perihelion polar winters by the precession of the equinoxes, as advanced by Croll; *directive*, in that they have imposed an appeal to energies now active as causes of retreat, and divested the problem of resorts to the fascinating but dangerous uses of suppositions and hypotheses.

They have, moreover, pointed out with unerring accuracy the vital conclusion that the same energies which have but recently converted the glacial lake beds of Canada into the most productive grain fields of the world will in time convert the tundras of to-day into the grain fields of to-morrow.[11]

The bearing of this conclusion upon the ultimate development of the human race is so far-reaching in its consequences that the great sacrifice of life attendant upon the prosecution of these researches stands forever as a memorial in the correction of the erroneous and wide spread conception that the earth is in a period of refrigeration, desiccation and decay; and establishes the conclusion that it is in the spring time of a new climatic control during which the areas fitted for man's uses are being extended and that the moss of polar wastes will be replaced by rye and wheat.

MARSDEN MANSON

SAN FRANCISCO, CALIFORNIA

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[7] *Ib.*, p. 286.

[8] *Ib.*, p. 288. See also photograph following p. 286 and p. 292.

[9] Address to the Commonwealth Club, San Francisco, Calif., November 7, 1916.

[10] Slight fluctuations in the retreat of the small residual glaciers in temperate latitudes are noted in the reports of the Commission on Glaciers of the International Geological Congress by Professor Harry Fielding Reid. But the great measures of the progressiveness of glacial retreat are in the past disappearance of the Pleistocene ice fields of temperate latitudes and the present retreat in the Antarctic and Arctic regions.

[11] See also Compte Rendû du XIième Congrès Géologique International, p. 1102. Stockholm, 1910.

EFFICIENT LABORATORY LIGHTING

Several notes have appeared in Science the past few years relative to the development of glass through which a proper spectroscopic correction could be secured for microscopic purposes. There are also on the market various microscope lamps designed to furnish a corrected artificial light for laboratory study.

These devices, though very satisfactory for small advanced classes, are in many ways undesirable for large classes of elementary students, and sitting, as they usually do, on the laboratory table, are more or less subject to breakage when used by large numbers of students.

The dark winter days during a part of the school year made it imperative that the large classes in agricultural botany at Oregon Agricultural College be provided with a light which would yield relative daylight values with temporary mounts and stained prepared sections. This has been attained most efficiently by the use of the General Electric Company's Ivanhoe Truetint Unit No. 748, known as the "Noon Sunlight" grade. This is a large, apparently blue shade, designed to cover the high-power nitrogen-filled Mazda lamp. Experience has shown that one of these units suspended two feet above the laboratory table and equipped with a one-hundred-watt bulb gives a superior light for four students. In this way, forty students at one time are being handled with ease on dark days, the illumination being ample even for the high-power dry or the oil immersion objectives.

The cost of the entire installation is approximately the same for four men as that of the usual microscope lamp designed for one person. To secure a fixture which would be near the table without obstructing it for laboratory work, the shade holders were suspended by nickel chains from the ceiling over the center of each table. The lack of rigidity of the fixture thus equipped is of special advantage in the elimination of breakage.

W. M. Atwood

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SCIENTIFIC BOOKS

The Elements of the Science of Nutrition. Third Edition. By Graham Lusk. Philadelphia, W. B. Saunders Co., 1917. Pp. 641.

It is sometimes said that the sciences and the fine arts are international in the broadest sense of the word; they do not recognize national boundaries or racial limitations. Nevertheless a nation may well be concerned about the accomplishments of its citizens in the pursuit of knowledge. "Knowledge once won," Gowland Hopkins has recently written in a commendable essay on medicine and experimental science, "is of no country; it is the common guerdon of mankind; but he who cares nothing as to where it grows seems to lack an element of patriotism."

From this standpoint American science need not be dissatisfied with the contributions which the workers in this country have made to the study of nutrition in the past decade. Lusk's "Science of Nutrition," which has established itself as a stimulating and comprehensive text-book, discloses the names of more than one hundred American investigators whose labors have helped, probably in larger measure than those of any other country, to bring new facts and permit new viewpoints in nutrition during the interval that has elapsed since the earlier (1909) edition of the book. Its size has been expanded from 400 to 600 pages not by the mere accretion of incidental observations but by the addition of carefully considered novelties which the later development seems to warrant as worthy of consideration.

The style and mode of treatment of the problems of nutrition remain essentially unchanged in the new edition. The historical method has been followed in a way that can not fail to interest those who are more familiar with the subject-matter, and that ought to enthuse the beginner. There is something almost inspiring in following the story from its beginnings in the days of Lavoisier down to the ingenious contrivances for respiration study and calorimetry so highly developed in the university laboratories and research institutes of the United States. A special new chapter is devoted to some of this modern technique that has furnished such helpful measurements of the basal metabolism of man and the domestic animals.

The novelties must be sought on every page; for the new edition is not an expedient of bookmaking but a record of progress. Among the major accessions are elaborate discussions of the possible processes of intermediary metabolism. To those who learned their physiology with a former generation the newer chemical language may seem almost incomprehensible. But Lusk properly remarks (p. 175): "One must know the life history of sixteen amino-acids in order to be familiar with the metabolism of protein. Though the extension of knowledge may have been at the cost of simplicity, yet order is being wrought out of apparent complexity. It is often difficult for an older generation to think in terms of the knowledge of a new. The author's father was a student at Heidelberg at the time when the modern chemical formulæ were introduced, when H—O became H_2O, and he recalled the distracted exclamation of one of the university professors, 'Ach Gott! wie kann man so lernen!'"

A new chapter on The Nutritive Value of Various Materials used as Foods develops the history of the latest standpoints which are threatening to upset so many of the currently taught doctrines. "It is evident from the material presented in this chapter," Lusk writes (p. 378), "that the science of nutrition includes something more than the production of energy from fat, carbohydrate and protein. There must be certain salts and certain qualities of protein in the diet, and there must be minute amounts of 'vitamins.' The chemical composition of the latter will some day be known, even as the chemical composition of epinephrin is known. Epinephrin, an essential of life, is present in the blood to the extent of 1 part in 100,000,000. In like manner, vitamins which are present in meat, milk, fresh green vegetables and grains are essential to the harmonious correlation of the nutritive functions of animals.

Nephritis, cardiac disease and other conditions involving acidosis are also considered in their relation to metabolism. A highly interesting and exceptionally timely chapter on Food Economics concludes the volumes. A few brief excerpts will suffice to indicate some of the attitudes of the author. After urging the sale of food by calories and not by pounds Lusk adds (p. 569): "The main objection that has been encountered to the sale of food on the caloric basis has been the sensitiveness of the business world to the introduction of a new and unknown quantity. Why not leave well enough alone? A more highly educated generation will, however, demand that its expenditure of thousands of millions of dollars for food shall not continue to take place in unfathomable depths of darkness." Again (p. 571): "The housewife should know about cooking, and both she and her husband should know something of the value of food. The sum wasted for alcoholic beverages would frequently be sufficient to turn the scale in favor of the proper nutrition of the family. Cheaper milk for the babies of the poor and adequate nourishment for school children are important factors in the situation. . . . As this book goes to press it seems that America herself is certain to face a food shortage before very long. This can be remedied by increasing the number of milch cows and by reducing the livestock raised for meat. The latter would free arable land for the production of grain and potatoes and save, for human consumption, grain fed to steers. It is quite certain that meat in the quantity it is consumed to-day is entirely unnecessary, and it is susceptible of scientific proof that mechanical work is more efficiently and economically derived from carbohydrate food than from meat."

When the author expresses his conviction that "in another decade the development of scientific knowledge will probably permit the formulation of the subject from the standpoint of physical chemistry" the reviewer is less sanguine regarding the complete dominance of a single mode of attacking the problems of nutrition. Against the author's published statement that he has no intention of again revising his book, protests are already being heard even from across the Atlantic. Success entails responsibilities.

Lafayette B. Mendel

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Occasional Papers of the Museum of Zoology, University of Michigan. Nos. 1–35, 1913–17 (each separately paged). Ann Arbor, published by the University.

Dr. A. G. Ruthven, the Director of the Museum of Zoology of the University of Michigan, is heartily to be congratulated upon the appearance of the first volumes of these "Occasional Papers" Nowadays when every one is continually receiving requests to subscribe to some new journal or other, this series comes as a refreshing delight; it is not published for sale! We learn that the papers are issued separately to libraries and specialists, and, when sufficient matter has accumulated, a title page and an index—an excellent index by the way—is prepared and the volume is sent forth.

The contents will appeal especially to the modernized systematist, who tries, at any rate, to take interest in ecology, zoography and the careful noting of life histories. We find notices not only of such astonishing novelties as *Lathrogecko, Pseudogonatodes* and *Calliscincopus* among reptiles, and of *Cryptobrachus* and *Geobatrachus* among amphibia, but of more general interest are the very interesting observations upon the egg-laying and hatching of several South American species of amphibia, of varied genera, in all of which some significant and peculiar adaptation or modification is recorded. The series is not, however, for the herpetologist alone. Reighard and Cummins have a model description of a new *Ichthyomyzon* with notes and figures of its appearance and customs. Other writers discuss crustacea, insects of various groups, trematodes, as well as birds and mammals.

That these articles were not chosen for the collection but simply represent the natural output for this comparatively new and hitherto little-known museum indeed augurs happily for the future of the series and for that of the museum as well. Workers in the Museum of Comparative Zoology at Harvard are perhaps naturally more *sympatico* than others and when they review their own museum's past it is not difficult for them to foresee the swift growth of another great university museum of similarly unrestricted interest and endeavor at Ann Arbor.

T. Barbour

SPECIAL ARTICLES

CONCERNING THE INFLUENCE OF THE AGE OF AN ORGANISM IN MAINTAINING ITS ACID-BASE EQUILIBRIUM

The importance of the maintenance on the part of the blood and tissue juices of a hydrogen ion concentration within certain narrow limits of variation has been established through the work of J. S. Haldane and L. J. Henderson. Recent investigations have not only served to emphasize the importance that the organism should maintain a certain acid-base equilibrium for its physiological life, but have also shown that when the mechanism which regulates this equilibrium is interfered with so that the hydrogen ion concentration of the blood is increased and maintained for an adequate time, the organism no longer functionates normally, but becomes pathological in certain of its reactions.

It is not the object of this note to enter into a discussion of the factors concerned in maintaining a normal acid-base equilibrium, nor to discuss those pathological conditions in which a variation from the normal is frequently observed. The object is to call attention to the influence of the age of the organism in controlling the mechanism by which the acid-base equilibrium is kept within the bounds of normality.

Some years ago, while conducting a series of experiments in which uranium nitrate was employed as the toxic agent to induce an acute nephritis, the observation was made that this substance was more toxic for old animals than for young animals.[1] This variation in degree of toxicity was expressed by the older animals becoming both albuminuric and glycosuric at an earlier period following the use of uranium than was the case with the young animals. Furthermore, the quantitative output in the urine of both albumin and glucose was greater in the old animals than in the young animals. When the kidneys of these animals were studied histologically there was found to exist more evidence of kidney injury in the organs from old animals than in those from young animals. In so far as the kidney was concerned in the reaction, uranium was more toxic in an old animal than in a young animal.

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[1] MacNider, W. deB., "On the Difference in the

In a later series of experiments[2] in which the age of the animals was taken into account, animals following an intoxication by uranium gave evidence of developing an acid intoxication much earlier than did the younger animals. The experiments also demonstrated that the acid intoxication in the older animals was of a severer degree than in the young animals. The evidence for the development of an acid intoxication in these animals of different ages consisted in noting the time of appearance and quantitative output in the urine of acetone bodies, and in determining the relative degree of tolerance for an alkali by the two groups of animals. The old animals showed an earlier appearance in the urine of acetone bodies, a greater quantitative output of these bodies, and a greater tolerance for an alkali than did the younger animals.

In these experiments it was furthermore shown, that by the intravenous use of an alkali in a young animal the kidney could be successfully protected against the toxic effect of an anesthetic while in the older animals the difficulty of furnishing this protection increased with the age of the animal.

In a recent study[3] of the relative toxicity of uranium nitrate in animals of different ages, the observation has been made that the old animals not only show a severer grade of acid intoxication as indicated by the appearance of acetone bodies in the urine than do the younger animals, but these old animals also show a more marked increase in the hydrogen ion concentration of the blood, which is associated with a more rapid depletion of the alkali reserve of the blood and a greater reduction in the tension of alveolar air carbon dioxide. Associated with this change in the acid-base equilibrium of the blood there develops a kidney injury which is histologically more marked in the old animals than in the young animals.

In a final series of experiments[4] it has been found possible to maintain in some measure the functional capacity of the kidney and the response of this organ to various diuretic substances by employing a solution of sodium carbonate to restore the alkali reserve of the blood and maintain an acid-base equilibrium of the blood which approaches in degree the reaction of normality. The ease with which the acid-base equilibrium of the blood can be restored and maintained in an animal intoxicated by uranium, and the degree of protection which is furnished the kidney is dependent upon the animal's age. The acid-base equilibrium is more easily restored and can be maintained for a longer time in a young animal than in an old animal. The protection of the animal against the toxic effect of uranium is more perfect in a young animal than in an old animal.

From the experiments which have been cited it would appear that there is a definite association between the toxic effect of uranium and its ability to induce an acid intoxication

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Response of Animals of Different Ages to a Constant Quantity of Uranium Nitrate," *Proc. Soc. Exp. Biol. and Med.*, Vol. XI., 159, 1914.

[2] MacNider, W. deB., "The Inhibition of the Toxicity of Uranium Nitrate by Sodium Carbonate, and the Protection of the Kidney Acutely Nephropathic from Uranium from the Toxic Action of an Anesthetic by Sodium Carbonate," *Jour. Exp. Med.*, Vol. XXIII., 171, 1916.

[3] MacNider, W. deB., "A Consideration of the Relative Toxicity of Uranium Nitrate for Animals of Different Ages," I., *Jour. Exp. Med.*, Vol. XXIV., p. 1, 1917.

[4] MacNider, W. deB., "The Efficiency of Various Diuretics in the Acutely Nephropathic Kidney, Protected and Unprotected by Sodium Carbonate," *Jour. Exp. Med.*, Vol. XXIV., 19, 1917.

and that the age of the animal very largely determines the rapidity of development and the severity of this intoxication.

When animals of different ages are intoxicated by this metal the factor of the age of the organism in the reaction is expressed by an inability of the senile animal to maintain with the same degree of perfection a normal acid-base equilibrium as is the case with the younger animal.

WM. DEB. MACNIDER

THE LABORATORY OF PHARMACOLOGY,
THE UNIVERSITY OF NORTH CAROLINA

BOSTON MEETING OF THE AMERICAN CHEMICAL SOCIETY. V

On the mechanism of the potassium chlorate-manganese dioxide reaction: RAYMOND F. BACON and B. W. MILLER. As the result of their experimental investigation of the mechanism of the so-called potassium chlorate-manganese dioxide reaction, the authors conclude that: (1) Avoiding local heating, potassium chlorate and manganese dioxide begin to react at 255° C. The most vigorous reaction occurs at 310° C. (2) The potassium chlorate oxidizes the manganese dioxide at the lower temperature to form a higher unstable oxide, which is decomposed later into manganese dioxide. It is impossible to isolate this intermediate oxide on account of the great velocity of the reaction. (3) This initial oxidation generates heat, and this, coupled with the heat applied, causes the reaction to go, with a very rapid rise in temperature. This high temperature causes certain secondary reactions to occur. (4) The first of these secondary reactions between the potassium chlorate and manganese dioxide results in the formation of manganous chlorate, which decomposes into manganous chloride, chlorine and oxygen. The manganous chloride is partially oxidized to manganese dioxide and chlorine. Potassium oxide reacts with manganese dioxide, in the presence of oxygen, to form potassium manganate, which is changed by some of the chlorine to potassium permanganate. The excess of chlorine escapes. Of the potassium chlorate used, only 0.503 per cent. enters into these changes. (5) An average of 5.428 per cent. of manganese dioxide is used up in this reaction. Almost all of this loss is accounted for from the soluble manganese compounds produced in the secondary reactions. (6) The manganese dioxide serves as an interacting catalyst in this reaction, hastening the speed of the change by actually reacting with the potassium chlorate, to form an intermediate oxide, which sets free the manganese dioxide again before the conclusion of the reaction.

The measurement of the compressibilities of solids under hydrostatic pressure up to 12,000 megabars: LEASON H. ADAMS and ERSKINE D. WILLIAMSON. The compressibilities of the following metals under hydrostatic pressures from two to twelve megabars have been measured by a comparative method—silver, bismuth, copper, zinc, brass, tin, cadmium, lead, gold, aluminium, tin-bismuth alloy. The results are accurate to about 1 per cent. of their values. In the case of the more compressible metals an estimation of the falling off of the compressibilities at higher pressures is obtained.

Compounds formed by the alkali oxides K_2O and Na_2O with the trioxides of aluminum and iron: GEORGE W. MOREY. A description of the preparation and properties of some alkali aluminates and ferrites.

Sulfuric acid as an acidimetric standard: MARSTON LOVELL HAMLIN and CHARLES BLAKE CLOUD. The preparation and use of 100 per cent. H_2SO_4 for a primary acid: nitric standard is described, previous work is cited, comparison of results with standardizations by other methods is given.

The production of ozone in the corona: F. O. ANDEREGG. One of the methods for the fixation of nitrogen is its "burning" in the electric arc, the combination being due chiefly to the ions. The laws that govern the important relationships between ionization and chemical action are still obscure. To simplify the problem the study with a single gas has been begun with the formation of ozone in the corona which is probably the simplest form of electrical discharge occurring at atmospheric pressure. Opposed to the ozonizing effect there is a deozonizing effect with a resulting equilibrium.

Some properties of the oxides of lead: L. H. ADAMS and H. E. MERWIN. The oxides PbO and Pb_3O_4 were prepared in well crystallized form and their densities and optical properties determined. The monoxide exists in two polymorphic modifications having an enantiotropic inversion point at about 570°. Some interesting effects of pressure on crystals of the yellow form of PbO are described.

A new illuminator for microscopes: ALEXANDER SILVERMAN. The illuminator consists of a small circular tube lamp surrounding the objective, and generated by a six-volt storage cell. It may be lowered into a hollow object, the lamp being attached to the microscope tube and moving with it. Especially convenient for the study of enamels, alloys, opaque objects and substances contained in opaque vessels. A model will be exhibited in operation.

The qualitative separation and detection of gallium: PHILIP E. BROWNING and LYMAN E. PORTER. A study of the occurrence of the element shows it to be most closely associated with Pb, Al, Fe, Mn, Zn and In. Analytically it falls into the Al group, its hydroxide being precipitated by NH_4OH in the presence of NH_4Cl and being soluble in an excess of NaOH. The chief analytical problem is its separation from Al and two methods are studied, both of which give satisfactory results. First, the method of de Bois Vaudran, precipitating $Ge_4(FeC_6N_6)_4$ by $K_4FeC_6N_6$ in the presence of strong HCl to about one third the volume of the liquid. Second, saturating a solution with HCl gas in the presence of ether, which throws out the $AlCl_3$ and keeps the Ga in solution.

The qualitative detection of germanium and its separation from arsenic: PHILIP E. BROWNING and SEWELL E. SCOTT. A study of the occurrence of the element shows it to be most closely associated with Ag, Pb, Hg, Cd, As, Sn, Zn, Ti and Cb. It falls in the analytical group with As and Sn since its sulphide is soluble in $(NH_4)_2S$. It is separated from Sn by treating the sulphides with $(NH_4)_2CO_3$, GeS_2 being soluble. From As it may be separated by treating a solution of the sulpho salts with ammonium acetate, acidifying with acetic acid and passing H_2S. As_2S_3 is precipitated and Ge remains in solution. The following modification of Buchanan's method was devised for the separation and detection of Ge. The germanium material was dissolved in strong hydrochloric acid (5–10 cm.^{3}) in a test tube some $KMnO_4$ added, to keep arsenic if present in the higher condition of oxidation and distilled into another test tube kept cool in water. After distilling about one half volume the Ge is found in the distillate by means of H_2S.

Silver anion: H. C. P. WEBER. It is customary to think of silver as a strictly monovalent element, which forms in solution a positive ion. When a solution of a silver salt is electrolysed at high current density a black deposit is formed at the anode which has been variously described as silver peroxide and as silver peroxynitrate, the formulas ascribed varying but tending to indicate the presence of trivalent silver. It is now shown [illegible] this compound we have silver which in tra[illegible] experiments acts as an anion, probably [illegible] a very unstable and intensely active [illegible] agent. It is not derived from hydrogen per[illegible] but rather of the permanganate type. [illegible] pound is of great interest in connection [illegible] valence of silver in particular, and [illegible] general.

The fixation of nitrogen with the si[illegible] discharge: FARRINGTON DANIELS and [illegible] WULF. The oxidation of nitrogen by [illegible] cold electric discharge has been p[illegible] No [illegible] energy is lost as heat, and under the [illegible] conditions nitrogen pentoxide instead of nitrogen peroxide is formed. This should simplify the absorption towers. Pressure favors this reac[illegible] but not the reaction which gives nitric o[illegible] Practical applications have failed bec[illegible] the action is too slow. A search for a catalyzer w[illegible] unsuccessful. Experiments with various types [illegible] discharge chambers look hopeful.

The displacement of nitric by carbonic acid in silver nitrate solutions and the relation of this re-action to the inclusion error in the silver voltameter: A. S. MCDANIEL and H. D. HINELINE. It has been shown that carbon dioxide reacts slowly with silver nitrate in aqueous solution forming [illegible] carbonate of silver and liberating free nitric acid. Crystals of the carbonate have been isolated and identified. The nitric acid liberated has been estimated by titration with iod-eosin and its amount compared with the silver contained in the crystals of silver carbonate. The reaction is believed to be as follows:

$$Ag\,NO_3 + H_2CO_3 \rightleftarrows Ag\,HCO_3 + HNO_3.$$

About one one-hundredth of one per cent. of the silver nitrate is converted to the carbonate. In the silver voltameter a clear solution of silver nitrate which has been saturated with CO_2 gives a deposit about 0.4 per cent. too heavy. This effect was first shown by Rosa, Vinal and McDaniel, but it was thought by them that the amount of CO normally present in air has no appreciable effect upon the mass of deposit. In the present investigation a few direct measurements have been made of the effects produced by one to ten times the normal amounts of CO_2 present in the air and while the results are incomplete they indicate that the effect of the normal amount of CO_2 in the air is not negligible and indeed may be larger than the inclusion error in normal deposits.

(*To be continued*)

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